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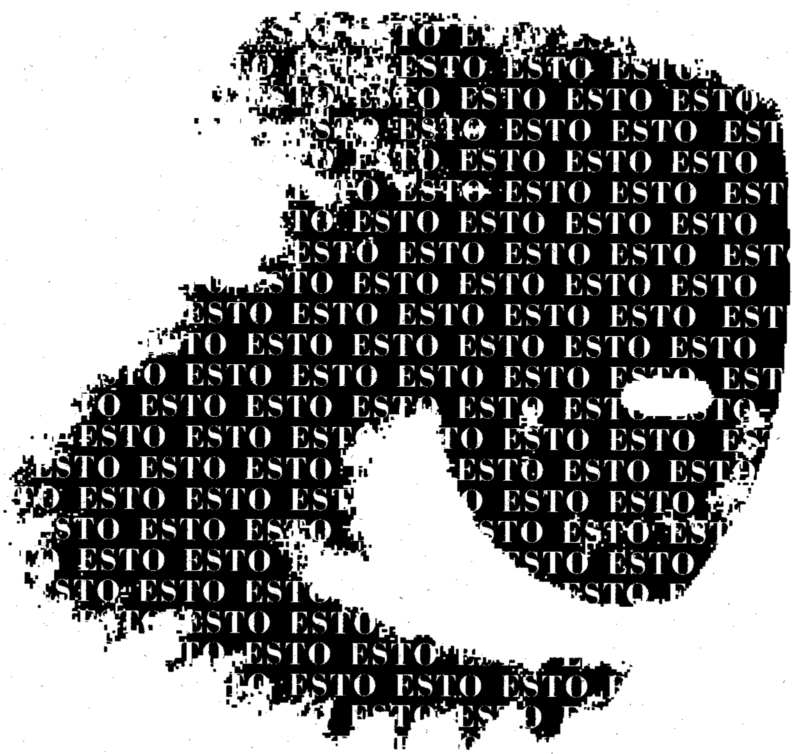

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C O N T E N T S

pean Union has now a significant gap with its main competitors in investment in RTD, particularly RTD investments by the private sector. At the same time, despite the many advances in completing the Internal Market, specific problems remain, particularly in the area of innovation and its diffusion, hampering competitiveness probably as much as the increasing gap in RTD investment. This can be easily acknowledged once the concept of innovation is understood as not being confined to technological improvements but also encompassing organizational aspects.

Employment on the other hand, has been one of the major areas of long-term policy concern in the EU since the dramatic rise in unemployment rates in the late 70s. The persistence of high unemployment rates reflects a variety of structural problems: the fragmentation and national regulation of product and service markets, the (lack of) response to innovation and competitiveness challenges and the structure of EU labour markets.

In other words, many different factors explain Europe's performance in competitiveness and employment. RTD and innovation undoubtedly play a key role since they affect firms' long-term capacity to stay in the market as active players, maintain and renew their range of products and services and ultimately create the conditions for sustainable employment. For open economies such as the European ones, any successful employment policy has to rely heavily on economic competitiveness. Competitive economies attract investors and create wealth and jobs. Economies with poor performance on the competitiveness front are unlikely to sustain any long-term credible employment strategy.

The demands and expectations of RTD policies to deliver on competitiveness have therefore increased strongly. Creating a 'knowledge-based' competitive advantage has become a central policy aim of the European Union. At the same time globalization and the emergence of powerful new technologies such as the cluster of new Information and Communication Technologies (ICT), are increasing further the openness of already, from an internal European market trading perspective, very open economies. This translates into an intensification of global competitive pressures, which at the level of the firm generate further transformation pressures. In other words, firms react to competitive pressure by intensifying their efforts to introduce new products, processes and new forms of organization.

Benchmarking the impact of RTD on competitiveness and employment in the context of Member States' policies will therefore require a thorough understanding of a complex range of factors and processes. They deal with structure and performance, not only of the knowledge base of the individual Member States but essentially with the overall functioning and efficiency of their economies, including the various links with and between different member countries' national innovation systems.

Science, technology and innovation are generally recognized as important determinants of economic well-being. Public support for R&D is therefore expected to have downstream impacts in terms of indicators such as competitiveness and employment. Benchmarks of performance along these dimensions, and of the R&D policies which have an eventual impact on competitiveness and employment, are thus highly desirable as inputs to improved policy-making.

Benchmarks provide standards against which performance can be measured or assessed. They allow comparisons to be made and help illustrate where improvements are possible. In a science, technology and innovation policy context, exercises which benchmark national R&D policies and educational standards, levels and attainments within the system. A well-educated population is better placed to take advantage of technological developments than a poorly educated one. Broad indicators of 'social and human capital' or 'social capability' are: percentage of GDP spent on education; percentage of working population with third-level qualifications; and the degree of participation in life-long learning.

Research capacity

The long-term strength of a country's research system is a function of the number and calibre of the researchers within it and the amount and quality of the research performed by them. Key indicators here are the proportion of scientists and engineers in the workforce; public investment in R&D; and the number of scientific publications produced per million of the population.

Technological and innovation performance

There are many traditional input and output measures for the technological and innovation performance of a country, including the amount of R&D performed by industry (as a percentage of GDP) and the number of patents per capita. To these the Expert Group added innovation expenditure as a percentage of sales in order to reflect a measure of intrinsic interest to industry.

Absorptive capacity

The ability of a country to absorb and exploit technology is an important reflection of overall innovation performance, exemplified by the successful diffusion of new technologies throughout an economy. Key indicators can thus be based on the capacity of firms to renew product ranges; on improvements in labour productivity; and on overall trade performance.

Analysis of the country data available for all the indicators above revealed wide disparities between EU Member States along all four performance-related dimensions. The analysis also uncovered strong positive associations between three of the four key concepts (research capacity, social capital and technological and innovation performance), but weak relationships between these three and the fourth concept, absorptive capacity. Leaving the concept of absorptive capacity aside for the

Figure 1. A Simple Model of an Innovation System and Related Performance Concepts

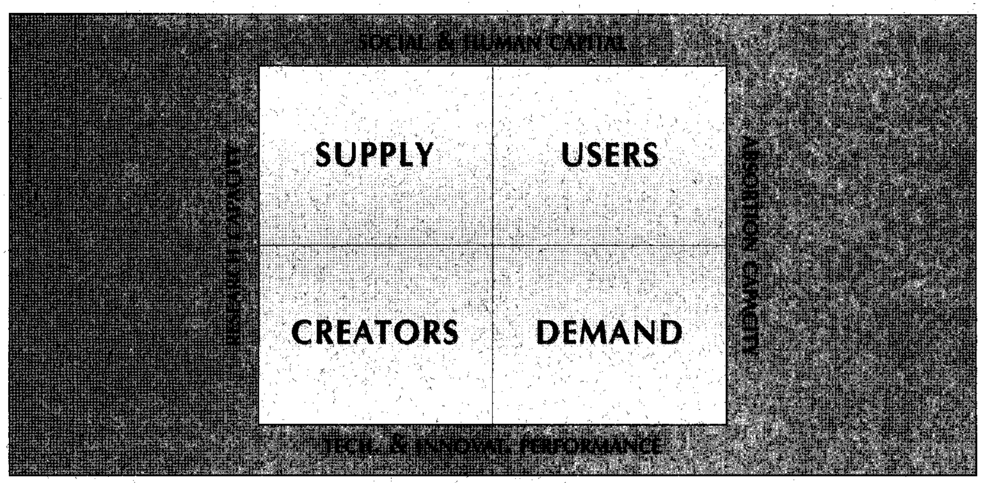
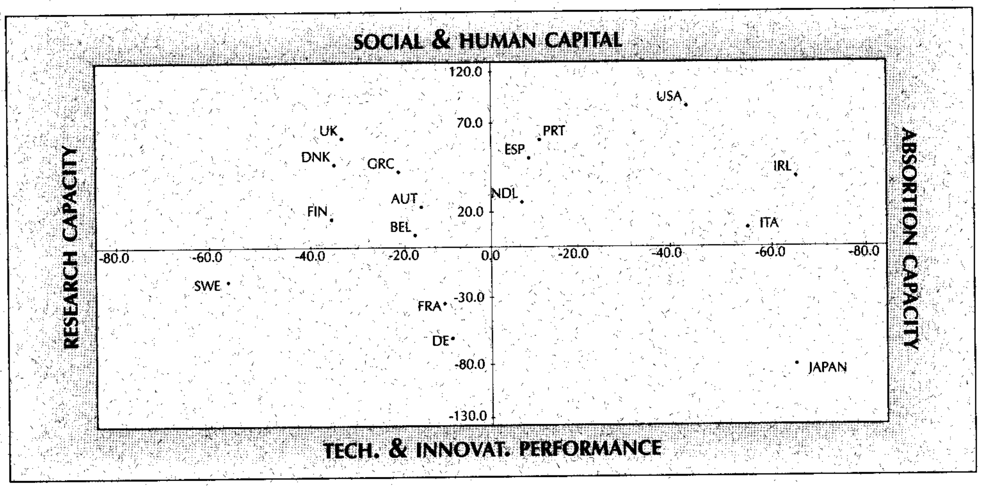


Figure 2. Performance Bias in EU National Innovation Systems



innovation heavily biased towards the diffusion of the results of its technological and innovative endeavours.

The evidence gathered and the insights gained from its analysis lends support to a benchmarking vision which goes beyond a focus on individual RTD indicators and concentrates instead on an approach which takes the systemic interactions between the various parts of a country's national system of innovation fully into account.

Benchmarking STI policies

Given that benchmarking exercises are meant to improve policy-making, it is important to move beyond comparisons of innovation system performance and forward to a more critical look at the policies which are designed, in the long run, to improve overall performance. In theory, benchmarking policy performance and impact requires:

- An adequate understanding of the different types of policies and policy instruments in use and the contexts in which they are applicable;
- Indicators of relative performance which can be used to compare the efficiency and effectiveness of individual instruments with others of a similar type;
- An understanding of the ways in which individual instruments are combined into effective policy mixes within national innovation systems;
- Estimates of the aggregate impact of the whole spectrum of instruments in use in different innovation system settings.

In practice, for all the reasons noted previously, we currently lack the ability to make adequate estimates of aggregate impact. It is possible to make crude correlations at the macro-level between indicators such as government expenditure on R&D and any of the innovation system performance indicators we have discussed so far, but these calculations tell us little useful about the causal links between policy and impact. Critically, they also tell us very little about the efficacy of particular policy mixes or individual instruments, or about the specific policy levers which need to be pulled if overall system performance is to be improved. The attention of policy-makers and policy analysts has therefore tended to focus more on evaluations of individual instruments and, recently, on improving our understanding of how these can be effectively combined. Innovation systems theory, too, has many implications for policy practice.

convergence of labour market practices and education. The life experience of people is what determines how they learn, communicate and interact in the knowledge society. The most appropriate method to achieve this at this stage of development of European collaboration might well be the Open Method of Coordination introduced at the Lisbon Summit (Rodrigues, 2002).

The third level refers to the regional level. As we have seen, there are several examples of successful policy initiatives at this level. Also there is a need to counter the built-in tendency of the knowledge society to reinforce regional inequality. In light of the efforts required to build the European Research Area, with its emphasis on European wide networks of excellence, this policy level will call for special attention. It is at this level too that policies supporting the absorptive capacity of small and medium-sized firms will be needed to strengthen and anchor local RTD and innovation clusters.

At each of these three levels, RTD-policy has both a responsibility to promote 'science' as one element of a common culture and a socio-economic obligation to promote well-being through innovation and competence building. When it is recognized that we are moving into a learning society and a knowledge based economy, there is a need to establish new strong public and private institutions that give the necessary weight to this dimension. It is not obvious that policy coordination in this new type of society should be left to ministries of finance and national (or European) banks. The Finnish example of a National Science and Technology Council having the Prime Minister as its chairman points in the right direction.

There are several dimensions that need to be given stronger emphasis in RTD-policies, where existing practices are scarce but where we find emerging good practices in member countries. One issue has to do with moving the focus away from manufacturing industries toward private and public services. A second has to do with understanding and mapping how knowledge production, diffusion and use take place in different sectors. A third is to reconsider the traditional split between what is private and public responsibility in, for instance, higher education. A fourth is the need to monitor, define good practice and support diffusion of organizational change in terms of management and work organization in both the public and the private sector.

When it comes to the use of benchmarking as the basis for policy learning, we propose that benchmarking be complemented with experience of the specific policy field and with insights into the systemic context for the specific policy field involved. Good practices need to be assessed in terms of how far they are 'generic', 'transferable' and 'durable'. Generic, robust and transferable practices are often procedural and institutional rather than associated with very specific forms of government intervention. From this perspective, the IRCE Group strongly endorsed the notion of intelligent benchmarking. A pre-requisite for such intelligent benchmarking would be that governments have established:

- institutions/mechanisms that help to sort out what are generic and robust trends rather than policy fads and fashion;
- institutions/mechanisms that help to define the specialization and institutional set up of national innovation systems as well as their strengths and weaknesses from a comparative perspective.

Conclusions

Rather than providing a detailed list of 'best-practice policies' in the area of the impact of RTD on competitiveness and employment, the IRCE Expert Group opted for a number of key messages

About the authors
Luc Soete is Director of MERIT and Professor of International Economics at the Faculty of Economics and Business Administration, Maastricht University, the Netherlands. Before coming to Maastricht in 1986, he worked at the Department of Economics of the University of Antwerp (UFSIA), the Institute of Development Studies and the Science Policy Research Unit both at the University of Sussex, and the Department of Economics at Stanford University. His research interests cover the broad range of theoretical and empirical studies of the impact of technological change, in particular new information and communication technologies on employment, economic growth, and international trade and investment, as well as the related policy and measurement issues. With respect to the latter he is currently one of the strong proponents of the 'new economy' phenomenon. Luc Soete is also director of the International Institute of Infonomics (IIoI).

This Editorial draws heavily from the work of the IRCE STRATA-ETAN Expert Working Group, set-up by the European Commission, DG Research, to conduct the Benchmarking exercise of National RTD policies with regard to their impact on Competitiveness and Employment. The Editors are grateful to all of them for their outstanding contributions and hard work.

The full IRCE Report as well as all the other 4 Expert Group reports belonging to the same exercise are available online at the CORDIS Website (**http://www.cordis.lu/rtd2002/era-developments/benchmarking.htm#frhlg**).

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Rapporteur

Mr Dermot P.O'DOHERTY, Senior advisor, Technological and Innovation policy, Sience, Technology and Innovation division, Forfás and InterTradeIreland, Dublin, Ireland, (**dermot.odoherty@intertradeireland.com**)

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Dr. Pascal PETIT, Directeur de Recherche CEPREMAP / CNRS, Paris, France, (**pascal.petit@cepremap.cnrs.fr**)

The Potential of Benchmarking as a Tool for Policy Learning

Jan Fagerberg, *University of Oslo*

Issue: 'Benchmarking' is an idea which has been attracting a great deal of attention recently. Although its critics may write it off as just another concept from the management literature that from time to time succeeds in finding its way from the business schools to the policy discourse, taking a broad historical perspective, the practice nowadays referred to as 'benchmarking' is not at all new and is potentially a very useful exercise, as exemplified in a recent benchmarking exercise by the European Commission (European Commission 2001).

Relevance: Arguably, one of the reasons for the increasing popularity of 'benchmarking' lies in the failure of much theory in this area to address real policy issues.

Introduction

'Benchmarking' is currently attracting a lot of attention in policy-making circles. However, some would write it off as just another concept from the management literature that from time to time succeeds in finding its way from the business schools to the offices of the commission and related places within the member countries. A similar case might be that of Michael Porter's 'diamond' a decade ago (Porter 1990): At the time it attracted a lot of interest but in the end the value for policy-makers was more limited. In one sense it is probably correct to say that benchmarking is a bit of the same. But as we shall see, although the concept may be new in this particular context, the practice it describes is not new at all. The reasons for this, it is argued, have to do with the failure of much theory in this area to address real policy issues. Finally, this article considers recent benchmarking exercises of the Commission (European Commission 2001), to see what lessons might be drawn from these for further work in this area.

Although it might be easy to write off benchmarking as another fashionable idea from the management literature, the underlying ideas are not new

A steamer from Yokohama

In December 1871 a steamer left Yokohama for the United States. On board were around fifty Japanese officials, including some very high-ranking people, and a number of students that were to be deployed in various Western universities. The officials, however, were on a mission to seek recognition for the new Japanese regime and to examine those aspects of Western civilization

In what is perhaps history's most ambitious benchmarking exercise, in the late 19th century the Meiji government of Japan sent out emissaries to examine aspects of western civilization and bring back a blueprint for the design of a modern state

The views expressed here are the author's and do not necessarily reflect those of the European Commission.

policies by learning from systematic comparative work. The knowledge that comes out of these exercises may be seen as a kind of "theory" although of a different nature than the formal type mentioned above. Rather it is an example of what the economists Richard Nelson and Sidney Winter have labelled 'appreciative theory' (Nelson and Winter 1982), i.e. theorizing that stays close to the empirical nitty-gritty, attempts to outline and interpret "stylised facts" and find out what the implications for policy may be.

A strand of 'appreciative theorizing' that may be relevant for benchmarking is that associated with the study of the policies pursued by countries attempting to catch up with the technologically and economically more advanced ones. The economic historian Alexander Gerschenkron is often recognized as a pioneer in the study of such processes.

His favorite example was Germany's attempt to catch up with Britain a century ago. While, when Britain industrialized technology was small scale and hence institutionally relatively undemanding, these conditions were, according to Gerschenkron, radically altered in the nineteenth century when Germany started to catch up. What he particularly had in mind was the seemingly in-built tendency of modern technology to require ever larger and more complex plants, with similarly changing requirements with respect to the physical, financial and institutional infrastructure. Hence, to succeed in catching up in such dynamic, scale-intensive industries, catching-up countries had in Gerschenkron's view to create new *"institutional instruments for which there was little or no counterpart in an established industrial country"* (Gerschenkron, 1962). The purpose of these would be to mobilize resources to undertake the necessary investments (structural changes) at the new and radically enlarged scale that modern technology required. Thus, following this view, emulation of institutions and policies at work in countries with superior technological and economic performance is by no means a guarantee for successful catch-up.

More recently the economic historian Moses Abramovitz, has applied the concepts 'technological congruence' and 'social capability' to the discussion of the 'absorptive capacity' of late-comers (Abramovitz, 1994). The first concept refers to the degree to which leader and follower country characteristics are congruent in areas such as market size, factor supply etc. The second points to the various efforts and capabilities that backward countries have to develop in order to catch up, such as improving education, infrastructure and, more generally, technological capabilities (R&D facilities etc.). He explains the successful catch up of Western Europe in relation to the USA in the post-war period as the result of both increasing technological congruence and improved social capabilities. As an example of the former he mentions how European economic integration led to the creation of larger and more homogenous markets in Europe, facilitating the transfer of scale-intensive technologies initially developed for US conditions. Regarding the latter, he points among other things to such factors as the general increases in educational levels, the rise in the share of resources devoted to public and private sector R&D and how good the financial system is in mobilizing resources for change.

Arguably, the concepts suggested in this literature may be of interest for the design benchmarking exercises. For instance the concept 'technological congruence' points to the fact that technological progress is not 'neutral' with respect to national characteristics. Hence one has to be specific in trying to sort out what the potential and requirements of the progressive technologies of the day really are (since these change over time), and how these requirements can be fulfilled in different settings and under different conditions. 'Social ca-

The success of emulation may depend on factors such as the 'technological congruence' and 'social capability' of the late-comers, which in turn shape their 'absorptive capacity'

The concept of 'technological congruence' points to the fact that technological progress is not 'neutral' with respect to national characteristics

'Social capability', refers to the fact that there are factors at the economy-wide (national, regional) level that matter a lot for the ability of firms to create, use and benefit from new technologies

period (as measured by the indicators). The performance of Finland is especially noteworthy, since it had quite high levels to begin with. Other countries that show some dynamism, though less, include Spain and Greece in the South, and the remaining small, developed economies in Northern and Central Europe. The larger economies by contrast show clear signs of a stagnating level of scientific and technological competence.

An important issue is to what extent these changes (in the distribution of scientific and technological capabilities) go hand in hand with changes in growth or trade performance as generally seems to be the case in the long run (Fagerberg, 1996). However, in this case some diversity might be expected because the time span is rather short (five years) and there obviously also are other factors at play. Still, the three most 'dynamic' countries in terms of technological capabilities, Ireland, Finland and Portugal, also are among the countries growing fastest in terms of labour productivity. Other countries that grew relatively fast include Austria, Greece and Sweden, all of which are countries with medium technological dynamism. Most of the large countries cluster towards the middle. As for trade performance in so-called high-tech products, the EU study reports that the best performance is recorded for Ireland, Netherlands, Finland, Belgium, Greece and Sweden, i.e., countries with high or medium technological dynamism. The exception appears to be Portugal, which has shown rather poor performance in high-tech trade in the period examined (1995-2000).

Summing up, a first conclusion is that there is clearly much more diversity among the smaller economies than the larger ones. The larger European economies generally appear to be less dynamic than many of the smaller economies in terms of upgrading science, R&D and innovation and in terms of performance. This may, however, be purely an aggregation effect, i.e. the large difference in size may simply be hiding the fact that there are large differences in dynamism within the larger economies. If this were the case it would raise the question of the most appropriate geographical scale for benchmarking. For instance it may be more appropriate to compare the smaller European economies with regions within the larger countries. This question is especially relevant since many of these regions, such as for instance the German 'Länder', actually have a lot to say when it comes to policy.

Second, there are clear signs of a process of technological catch-up taking place within Europe, with a group of less-advanced economies narrowing the gap in scientific and technological capabilities very rapidly. However, with the partial exception of Ireland, the gaps remain very substantial. Finland or Sweden, for instance, do three to four times as much R&D (as a share of GDP) as do Spain and Portugal, with Greece at an even lower level. Other indicators of technological capability confirm this pattern. As is now commonly acknowledged, the progressive technologies today are based to a much larger extent than in the past on the exploitation of science, organized R&D and highly skilled labour (Fagerberg et al., 1999). This raises the question of the extent to which the efforts undertaken by these countries in generating such technological capabilities – or 'absorptive capacity' – are sufficient for any 'catch-up' to be sustainable in the longer run. A comparison – or 'benchmarking' – with other countries that have been catching up rapidly during the last decades such as, for instance, some of the so-called 'newly industrializing countries' in Asia may be helpful in this regard. One fact that would have been revealed by such a comparison is that some of these Asian economies, Korea and Taiwan in particular (Lall, 2000), have for several years now invested heavily in technological capabilities, so that nowadays their capabilities are far ahead of the catching-up countries in Europe.

The three most "dynamic" countries in terms of technological capabilities, Ireland, Finland and Portugal, also are among those growing fastest in terms of labour productivity

The larger European economies generally appear less dynamic than many of the smaller economies in terms of upgrading science, R&D and innovation and in terms of performance

There are clear signs of a process of technological catch-up taking place within Europe, with a group of less-advanced economies narrowing the gap in scientific and technological capabilities very rapidly

Keywords

benchmarking, technology, growth, Europe, Japan

Note

1. Unfortunately, space does not allow us to document these trends in an extensive manner, so readers interested in a more detailed account will have to consult the original source.

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Contacts

Jan Fagerberg, Centre for Technology, Innovation and Culture, University of Oslo

Tel.: +47 22 84 06 00, fax: +47 84 06 01, e-mail: **jan.fagerberg@tik.uio.no**

Professor Jan Fagerberg, Instituto Superior de Economia e Gestão, Universidade Técnica de Lisboa, Portugal

Tel.: +35 19 63 414 170, fax: +35 12 13 922 808, e-mail: **jfagerberg@iseg.utl.pt**

Dimitris Kyriakou, IPTS

Tel.: +34 95 448 82 98, fax: +34 95 448 83 39, e-mail: **dimitris.kyriakou@jrc.es**

About the author

Professor **Jan Fagerberg** is affiliated with Oslo University's Centre for Technology, Innovation and Culture (TIK), where he is responsible forthe Centre's doctoral programme. Previous affiliations include the Norwegian Ministry of Finance, the Norwegian Institute for Foreign Affairs(NUPI) and the University of Aalborg. He holds a D. Phil. from the University of Sussex (1989) Science Policy Research Unit (SPRU) and holds degrees in history, political science and economics. A visiting professor at several foreign universities, he holds senior positions in Norway and servesas a consultant to many international organisations. His research interests focus on the impact of technology on trade, competitiveness and growth and more recently on globalisation of innovation. He has published extensively on these and related topics in books and major journals.

vidual instruments are combined into effective policy mixes within national innovation systems;

- Estimates of the aggregate impact of the whole spectrum of instruments in use in different innovation system settings.

None of these are easy tasks, but analysing the aggregate impact of multiple policy instruments is undoubtedly the most difficult. Correspondingly, the attention of policy-makers and policy analysts has tended to focus more on evaluations of individual instruments than on the effectiveness of 'policy systems' as a whole, and more on the design of individual policy instruments than on the construction of coherent and appropriate policy portfolios.

STI policy from a systemic perspective

Innovation systems theory furnishes a number of helpful insights into the functioning of such systems and has many implications for policy practice. In its simplest form, innovation systems theory draws upon general systems theory by defining 'systems' in terms of a number of 'actors' (often represented diagrammatically by 'boxes') and the relationships between them (which are usually depicted by 'arrows' suggesting flows of information, money, influence etc.) There are many lessons to be learnt for the formulation and benchmarking of individual policy instruments from the many studies and evaluations which have been conducted of the relationships between specific components of particular innovation systems. There are also many that can stem from a more holistic appraisal. The first of these is based on our current understanding of the complexity of modern innovation systems, each of which is composed of many different types of actor (multiple boxes) interacting in numerous and diverse ways (multiple arrows). In such systems, system performance is often determined or regulated by the weakest node (i.e. the weakest link in the chain). The implication for policy formulation, therefore, is that policy interventions could benefit from targetting the weakest links. Similarly, attempts to benchmark innovation systems and the impact of policies on system performance should also concentrate on the identification and characterization of weakest links.

A second lesson which stems from the complexity of innovation systems is that individual policy instruments applied in isolation are unlikely to have a dramatic impact on overall system performance, although in theory this is exactly what could happen if policies are targeted accurately at extremely critical weak links. In practice the 'strategic intelligence' required to identify critical nodes is woefully inadequate. In complex systems, too, there are likely to be many weak nodes, and even accurate targeting of an individual weak link is only likely to produce incremental improvements unless other weak links are also addressed.

A corollary of all of this is that successful attempts by public policy-makers to improve the performance of complex innovation systems are more likely to consist of the application of a broad portfolio of policy instruments than the application of any one instrument in isolation.

Applying a successful broad mix, however, again requires high levels of 'strategic intelligence' about the existence of weak links. It also demands an appreciation of the efficacy and appropriateness of individual policy instruments in different settings. In turn, this emphasizes the need for constant experimentation and evaluation in the use of single instruments and combinations of instruments, with the results of these assessments continually feeding back into policy formulation discussions.

Figure 1 is a simple representation of an innovation system comprising four interdependent sec-

Due to complexity issues, the attention of policy-makers and policy analysts has tended to focus more on evaluations of individual instruments than on the effectiveness of 'policy systems' as a whole

Innovation systems theory furnishes a number of helpful insights into the functioning of such systems and has many implications for policy practice

One of the implications of a systemic perspective is that attempts to benchmark innovation systems and the impact of policies promoting system performance should concentrate on the weakest links

Table 1. Overview of Science, Technology and Innovation Policies at work in the EU

Reinforcement Policies for Public Sector Knowledge Users

- Public support to education institutions and programmes
- Actions to raise awareness on S&T studies (many countries) and technical vocational courses (NL), or awareness of science in the larger public e.g. promotion at primary and secondary schools (SE)
- Creation of Interdisciplinary Graduate Schools (DK), Graduate Schools system (FI, SE)
- Modernization of vocational schools (DE) and apprenticeship system (UK)
- Increased funding for Polytechnics

Bridging Initiatives between Public Sector Knowledge Users and Knowledge Creators

- Collaborative programmes between universities and high education establishments
- IT infrastructures for science, industry and public e.g. DE

Reinforcement Policies for Public Sector Knowledge Creators

- Public support to universities and public research labs (all EU) with focus on excellence poles
- [illegible] of public research organisations (e.g. DE, IT, GR, SE, UK) and of status of career of researcher (e.g. GR, NL, UK)
- New university or research centre creation (ES, GR, LU)
- Targeted business-oriented R&D programmes carried out by PRIs (many countries) e.g. PAT (IE)
- Support to Young Scientists (many countries) e.g. START (AU), DK, YPER (GR)
- Improvement of doctorate and post-doc research (several countries) e.g. ES, FI, PENED (GR), IT, PT
- Support for integration of research by various PRI e.g. inter-university attraction poles (BE)
- Support for internationalization of research (most countries)
- Attraction of foreign researchers: e.g. DE, ENTER (GR)

Bridging Initiatives between Public and Private Sector Knowledge Users

- Role of Polytechnics, Technical Lyceums to support companies (AU, FR, DE), Technocentres (NL)
- Training in ICT (many countries)
- Lifelong Learning initiatives (several countries) e.g. Open Universities for Adult Education (FI), retraining of labour force (NL), Adult Education Programmes (SE)
- Promoting positions for graduates (several countries) e.g. FR, IT, PT, KIM (NL), TCS (UK)
- Innovation and entrepreneurship courses at high schools (most countries) e.g. Science Enterprise Challenge (UK)

Bridging Initiatives between Public and Private Sector Knowledge Users and Creators

- Cluster policy e.g. AU, BE, DK, FI, Innonet in DE, GR, NL
- Regional growth centres: co-operative centres gathering technology services, training, firms, R&D (DK); Centres of Expertise (FI); Regional networking initiatives InnoRegio, Innovative Regional Growth Poles (DE)

Bridging Initiatives between Public and Private Sector Knowledge Creators

- Mobility programmes for researchers in industry (most countries) e.g. FIRST (BE), Torres Quevedo (ES), CIFRE & CORTECHS (FR), PT, Industrial PhD programmes (DK, SE)
- Spin-off promotion programmes (most countries) e.g. A+B (AU), contest (FR), EXIST (DE), PRAXE (GR)
- Third Mission for universities (several countries) e.g. ES, SE
- Legal changes in PRIs to promote spin-offs e.g. FR, ES
- Liaison Offices at universities (most countries)
- Science Parks and Technopoles (most countries)
- Grants for collaborative research projects (most countries) or networks e.g. large cross-disciplinary research groups (DK), PROFIT (ES), Tekes (FI), FR, Leitprojecte (DE), LINK and Faraday Partnerships (UK)
- Public-Private Competence Centres e.g. Kplus (AU) and networks (DE), SE
- Technology diffusion centres and networks (most countries) e.g. collective research centres (BE), GTS (DK), technological centres (ES), CRITT and RDT (FR), AKMON (GR), Institutes of Technological Development (IE)
- Support to R&D in PRIs with potential for commercial exploitation (most countries)

Reinforcement Policies for Private Sector Knowledge Users

- Innovation-oriented Business Support structures (most countries) e.g. Syntens (NL), KETA (GR), Luxinnovation (LU), ALMI (SE)
- Support for technological development in firms (most countries)
- Support to counselling activities in firms (most countries) e.g. National Workplace Development Programme (FI)
- Support for training in firms (most countries) e.g. CRECE (ES)
- SME specific financial programmes (most countries) e.g. KMO-Innovatie programme (BE), Danish Growth Fund (DK)
- Entrepreneurship promotion programmes (many countries) e.g. entrepreneurship training (FI)
- Incubators (most countries): space, finance and advice in the same place
- Capital and Seed Investment (most countries) e.g. Sitra (FI)

Bridging Initiatives between Private Sector Knowledge Users and Creators

- Demonstration activities targeting companies e.g. [illegible] (AU)
- Mentoring schemes between large and small firms e.g. PLATO (BE)
- Support for co-operative R&D projects linking developers and users of new knowledge

Reinforcement Policies for Private Sector Knowledge Creators

- Support for R&D projects in companies: grants, loans, capital investment, guarantee mechanisms (most countries) e.g. CDTI (ES), ANVAR (FR), ProInno (DE), Agencia de Inovaçao (PT), SMART (UK)
- Support for R&D programmes conducted by business consortia e.g. IT
- Tax incentives for R&D in companies (AU, BE, ES, FR, IE, IT, NL, PT, UK)
- Risk and Seed Capital Funds, Business Angel networks (most countries)

provides a strong argument for the development of 'systemic' policies in addition to 'reinforcement' and 'bridging' policies. It also necessitates an appreciation of weak spots in current policy mixes and the formulation of appropriate steps to rectify these weaknesses.

Eliminating weak spots in policy coverage across the EU concerns policies covering the upper right hand sector in Table 1, i.e. innovation and diffusion-oriented policy instruments aimed at Private Sector Knowledge Users. This is where most jobs and value added are created in the whole system, making it imperative that policy-makers reinforce this node and link it to the rest of the system. Admittedly jobs and wealth are also created in the lower-right sector (Private Sector Knowledge Creators), and these have important implications for competitiveness in the long term, but the point here is that policy mixes which address the upper-right hand sector of the innovation system will produce stronger impacts on the overall productive capacity of the economies in which they are located. While taking care neither to abandon nor neglect reinforcement and bridging strategies in other parts of the innovation system, enhanced attempts to strengthen absorptive capacity would be welcome.

The development of policies to fill this gap would benefit from an increased understanding of innovation dynamics at the level of the firm. Recent studies in this field, in particular the Community Innovation Surveys, have demonstrated the importance of complex interdependencies between firms and a variety of other organizations in both the genesis and the adoption of innovative strategies. In particular, it is now evident that many of the target firms for policies in the upper right hand sector are not mere passive absorbers of the knowledge and innovative technologies produced in the other sectors. Rather, innovation processes often benefit from their more active interaction with other actors over prolonged periods of time and their involvement in many, if not most, of the stages from conception to eventual consumption. Policies are needed, therefore, which encourage this interaction.

Besides pinpointing and rectifying gaps and weaknesses in the system, a further implication of the adoption of a systemic perspective is the need to develop policies which take into account the interactions between all parts of the system. In particular, this involves building bridges between all nodes and not only between pairs of nodes. In Table 1, such policies are mainly located in the central sector, which has not been the traditional focus of STI policy instruments. In this sector, policies should strive to blur the frontiers between knowledge creators and users, and between private and public actors, with an emphasis on mutual learning and the joint shaping of mutually beneficial innovation strategies. Cluster policies are typical examples of attempts to develop such systemic policies, as are policy packages which link policy instruments in such a way as to provide appropriate support to target firms at different points during the innovation process.

Furthermore, if STI policies are to be fine-tuned to the needs of a particular innovation system, better linkages are needed between this and other policy spheres, notably those of industrial and business development and education and training. The adequacy of such links – often exacerbated by ministerial 'turf wars' – can be approved across the European Union, and network failures of this nature in the policy-making sphere consequently constitute a further challenge to the development of systemic STI policies.

Benchmarking lessons

Table 1 provides a simple benchmarking framework which can be used to classify and characte-

One of the weakest spots in policy coverage in the EU concerns innovation and diffusion-oriented policy instruments aimed at private sector knowledge users – the area where most jobs and value added are created in the whole system

Besides pinpointing and rectifying gaps and weaknesses in the system, a further implication of the adoption of a systemic perspective is the need to develop policies which take into account the interactions between all parts of the system

Conclusions

This article has provided a framework which can be used to characterize STI policy portfolios throughout Europe. Hopefully, national (and regional) policy-makers will find this helpful in framing, revising and fine tuning their STI policy mixes as they attempt to address weak links in their innovation systems. The following steps could form a useful part of any such efforts:

- Develop a systems perspective in order to understand how policies relate both to each other and to innovation system needs;
- Base policy prescriptions on analyses of as much 'strategic intelligence' as possible, making every effort to identify weak nodes within the innovation systems addressed and targeting these first;
- Attempt to construct a policy portfolio which addresses as many of these weaknesses as possible, and don't rely on a single policy instrument;
- Include reinforcement measures which strengthen the knowledge base, but not at the expense of accompanying measures which promote diffusion and the exploitation of this knowledge;
- Include measures aimed at human resource development which strengthen competence and lead to increases in social capital and absorptive capacity;
- Include 'bridging' measures aimed at improving knowledge and information flows;
- Make a concerted effort to develop 'systemic' policies which link organizations of various hues and encourage the sharing of know-how and competence;
- Experiment, evaluate and feedback this 'strategic intelligence' into policy formulation.

Understanding Innovation: the need for a systemic approach

Dermot O'Doherty, *InterTrade Ireland* and Erik Arnold, *Technopolis*

Issue: The theoretical and research basis of the IRCE (Impact of Research on Competitiveness and Employment) benchmarking activity offers important insights into both possibilities for and limits to benchmarking national performance and also about aspects of innovation policy.

Relevance: Implementing more systemic measures and assuring consistency among them is not a trivial task in real administrations, which are typically compartmentalized into different ministry and agency 'silos.'

Key lessons from the IRCE study

The need for a systemic approach to understanding the relationships between science, technology and innovation (STI) and socio-economic development: There is not a simple one-way relationship between the 'knowledge-production' and 'knowledge-absorption' aspects of an innovation system.

Both nodes and flows are important in innovation systems, since knowledge diffusion and spill-over processes, combined with excellent absorptive and learning capacities among agents in the system, are key aspects of such systems. Accordingly, identification of bottlenecks and lock-ins (i.e. weaknesses) is of primary importance, because these can hamper the functioning of the system as a whole. In this context, intermediaries also have significant roles as bridge-builders or facilitators between elements of the system. An evolutionary approach indicates that situations are always context specific and path-dependent. Many changes within systems are incremental. Human and social capital provide the oil necessary for lubricating the innovation system.

The need for a systemic approach

Over the past ten to fifteen years, there has been a major shift in our understanding of the relationships between research, innovation and socio-economic development. The concept of a National (or Regional or Sectoral/Cluster) Innovation System has emerged (Figure 1) incorporating all the actors and activities in the economy in knowledge production and absorption processes that are necessary for industrial and commercial innovation

There is no simple one-way relationship between the 'knowledge-production' and 'knowledge-absorption' aspects of an innovation system, hence a systemic approach is needed to understanding the relationships between science, technology and innovation

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systems, where detailed producer-user interaction is a prerequisite for success. Constant interaction and co-operation between different functions such as R&D and marketing within the firm, between firms themselves as well as with their external economic and political environments, leads to continuous learning and better exploitation of available knowledge - both codified and tacit. With regard to the specifics of this kind of cooperation Nelson (1993), for example, notes that: "to orient R&D fruitfully, one needs detailed knowledge of its strengths and weaknesses and areas where improvements would yield big payoffs and this type of knowledge tends to reside with those who use the technology, generally firms and their customers and suppliers. In addition, over time firms in an industry tend to develop capabilities - largely based on practice." Industrial districts or other kinds of clusters can be especially important as locations where co-operation in innovation is kept dynamic by the forces of competition.

Evolutionary Approaches

Knowledge and innovation systems do not emerge fully-grown but evolve over long periods of time. It is difficult to talk about concepts such as the 'optimal development' of innovation systems as the evolutionary learning processes that characterize such systems are subject to continuous change. Since actors and innovations co-evolve to adapt to their environments, their success can be very context-dependent. What works in one place and time may not succeed in another. Technologies spread at different speeds and in different ways, depending on the nature of the developmental and absorptive capacities of firms as well as on other economic and social actors and factors and their national environments. Such systems never reach a state of static equilibrium. An evolutionary approach to the development of 'innovation systems' stands in contrast to the more traditional linear view that technology develops and diffuses according to a relatively well-behaved pattern locally, nationally and finally internationally and that national levels of technological performance tend to converge in the longer run.

While evolutionary theory about the development of knowledge and innovation systems stresses the interdependence of actors and innovations, it does not exclude radical innovation. Innovations – both radical and incremental – are always based on some existing knowledge, but may also be based on some new knowledge. Incremental or 'imitative' innovations, which seek limited improvement of existing products and processes and which are sometimes seen as 'diffusing' new technologies, are the numerically and economically dominant variety. While the creation and flow of new knowledge has traditionally had high status and attracted policy attention and funding, the working and reworking of the stock of knowledge is much more important for economic development. Since technological change and economic innovation drive the capitalist economy, creative imitation is the central process in capitalist economic development (Arnold and Bell, 2001).

Path dependency

From an evolutionary perspective history really matters in the process of knowledge accumulation and innovation. Firms and economies on a path of growth or stagnation tend to persist with this pattern. This phenomenon is linked with the concept of virtuous and vicious circles of development. Nobel prize winner Douglass C. North contended (1990) that "path dependence is one of the remarkable regularities of history (....) the difficulty of turning economies around is a function of the nature of political markets and, underlying that, the belief systems of the actors."

A major and increasingly common feature of all innovation systems is that innovators rarely innovate alone. Industrial districts or other kinds of clusters can therefore play an important role in keeping innovation dynamic

Since actors and innovations co-evolve to adapt to their environments, their success can be very context-dependent. What works in one place and time may not succeed in another

While the creation and flow of new knowledge has traditionally had high status and attracted policy attention and funding, the working and reworking of the stock of knowledge is much more important for economic development suddenly mushroom to increase productivity more dramatically in some sectors rather than in others. Since successful growth involves systems-wide effects, it depends on there being an adequate quantity of relevant human skills and capital, and requires that these be of high average quality. Otherwise, human capital itself becomes a bottleneck. Successful innovation systems therefore provide wide access to good quality education and training, rather than focusing on the education of a small élite.

Higher education is also important for the development of innovative research and the ability to acquire and adopt it. Hence, some new growth theories have tried to build more complex models - accounting for human capital formation by giving prime importance not just to education itself, but also to some of its by-products such as research and innovation.

Regional dimensions

Regional industrial systems based on local learning networks are potentially more flexible and dynamic than those in which learning is confined to individual firms. Regional or local learning networks can allow for information flows, mutual learning and economies of scale. Robert Putnam (1993), for example, contrasts the impacts of Silicon Valley and Route 128 in the US. He cites Silicon Valley in California where a group of entrepreneurs, helped by research activity in the local universities, contributed to the development of a world centre in advanced technology. He has commented that "The success is due largely to the horizontal networks of informal and formal cooperation that developed among fledgling companies in the area". By contrast, on the Route 128 corridor outside Boston, lack of inter-firm social capital has led to a more traditional form of corporate hierarchy, secrecy, self-sufficiency and territoriality.

Absorptive capacity

In addition to social capital and the related phenomenon of networks (and particularly inter-firm networks) innovators' 'technological capability' (Arnold and Thuriaux, 1997) and their 'absorptive capacity' (Cohen and Levinthal, 1990) are two factors that are key to the understanding of learning-related development processes within the national innovation system (NIS). The ability of companies to learn depends on their internal capabilities, represented by the number and level of scientifically and technologically qualified staff they employ. R&D is largely financed and performed within the business sector and has two 'faces' (Cohen and Levinthal, 1989) - the *learning* face, which acquires and absorbs technology; and the *innovative* face, which seeks and applies new knowledge. Firms must do enough R&D to be economically dynamic and to have the 'absorptive capacity' to conduct a professional dialogue with the state research institutions and other external sources of knowledge.

The optimum level of internally-generated research and knowledge, versus externally-sourced technologies, will depend on the strategy and level of development of the entity concerned, whether it be a firm, industry, region or country. However, all are users of the existing 'stock' of knowledge, whatever the 'flow' into that stock for which they are responsible. So even in the most developed and sophisticated contexts, absorptive capacity will be significant.

The role of intermediaries

The role of 'intermediary institutions' such as applied research institutes and research associations, as well as other public and private intermediaries within the NIS, is also often underestimated or misunderstood. They typically have relatively low status compared with universities and basic science institutes. They can perform

Regional industrial systems based on local learning networks are potentially more flexible and dynamic than those in which learning is confined to individual firms

In addition to social capital and networks, innovators' 'technical capability' and 'absorptive capacity' are two key factors for the understanding of learning-related development processes within innovation systems actors involved in setting research and innovation policy are therefore needed. This applies both 'vertically' (e.g. between regional and national policy) and 'horizontally,' as between research and innovation funders. For 'weak' coordination to work, of course, there needs to be a fairly strong visioning mechanism to promote coherence among policies of different actors. This needs a combination of Foresight, the creation of arenas where policy can be widely discussed and a high-level mechanism to focus and endorse the vision. A well-known example of these is the Finnish National Science and Technology Policy Council, which is chaired by the Prime Minister.

Since systems failures and performance are highly dependent upon the interplay of characteristics in individual systems, there can be no simple rule-based policy as is possible in relation to the static idea of market failure. Rather, a key role for state policy-making is 'bottleneck analysis' – continuously identifying and rectifying structural imperfections. Intelligent benchmarking – which considers and compares the contexts of indicators and policy interventions, as well as describing the interventions themselves– is needed if policy systems are to learn from each other. There is no universally applicable 'best practice' to be discovered through benchmarking, however, only practices that work in particular times and places. The needs and characteristics of individual innovation systems change over time as they develop and evolve.

However, analysis is really useful when one or more actors can act as change agents. These may be specialized funding agencies within the research and innovation system, but periodically there is also a need to step outside the system and review structures. Radical changes in organizational structures rarely come from within.

A final conclusion, therefore, is that innovation systems are too important to be left to the actors involved. A degree of political interest and concern is required, both to prevent stagnation and to encourage development.

The culture in many European countries that ascribes high status to the production of knowledge and low status to knowledge use, incremental development and creative imitation, is an obstacle to innovation

The Lab and the Labour Market

Gerd Schienstock, *University of Tampere*

Issue: Although a positive relationship appears to exist between public R&D spending, economic growth and competitiveness, the concrete results also depend on the way in which R&D funding is targeted.

Relevance: The fact that cooperation with other knowledge producers enhances companies' innovativeness and job creation capability suggests that policy-makers could usefully include in their arsenal a network-facilitating approach to innovation policy to enable the efficient use of new knowledge.

Introduction

High unemployment rates in many industrialized countries have made the issue of job creation of new jobs a matter of highest societal and political concern. Expanding both public and private R&D has been proposed as a part of strategies to tackle the problem of unemployment. In what follows, we will try to elucidate some of the issues in the often very complex relationships between these two variables on both the macro and the micro level. We will first address the question of the extent to which increased public spending on R&D will contribute to the creation of new jobs and to growing employment. As aggregated variables do not tell us much about the mechanisms by which knowledge is applied and employment created, we will focus our attention on the micro level in the second part of the article. On the basis of company survey data we will analyse how companies' R&D spending is linked with their innovation activities and employment practices.

The macro-economic analysis

The question of the extent to which public R&D investment pays off in terms of job creation has been raised on numerous occasions (Fagerberg, 2002). Many attempts have been made to research the contribution of public R&D spending to economic growth and competitiveness. But while it is widely accepted that there is a positive relationship between R&D, growth and productivity in general, quantitative results vary. On the basis of these contradictory findings it is difficult to give policy-makers clear advice about how to obtain optimal results (Tsipouri, 2000). Moreover it is even more difficult to come to any straightforward conclusion about the precise impact of public R&D spending on employment. There is growing recognition

In the context of the relatively high levels of unemployment affecting many areas of Europe, there is considerable interest in the employment-creation potential of R&D

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Product innovations, on the other hand, can be seen as a major creator of new jobs as they often entail setting up new production capacity. Of course, if new products only replace existing ones, the net effect is likely to be no more than a shift in employment from one production process to another rather than an overall increase in employment. The extent to which new jobs are created also depends on the type of the production process. Capital-intensive production of new products will bring about less direct employment than human-capital-intensive production. Moreover, the extent to which new jobs are created also depends on organizational structures and management practices. We also have to take into account that product and process innovation often occur concurrently, implying that the positive employment effects of new product innovations will partly be tempered by the effect of new processes, and vice versa.

We can conclude, therefore, that it is very difficult to estimate precisely potential employment effects of investment in R&D. This is so firstly, because of the complexity of the relationship between R&D and new scientific knowledge, and secondly because of the complexity of the links between innovation and its sources. Whether investment in scientific and other research will bolster innovation depends to a great extent on the efficient organization of knowledge flows in the science and technology space. Finally there is a complex relationship between innovation and employment. For example, product and process innovations may have partly contradictory employment effects. The employment effects of new innovations depend a great deal on the way in which companies develop and organize their new activities. When companies derive competitiveness from a virtuous circle which builds more explicitly on exploiting the flexibility and creativity of their workforce, then the innovation activities of companies lead to growing employment. We also have to analyse possible feedback. Clearly innovations may potentially undermine the conditions necessary for their own implementation if rather than create jobs they destroy them (Lundvall and Archibugi, 2001). One can hardly imagine that social capital –which is a key basis for the effective functioning of innovation networks– can be accumulated in a society in which the level of unemployment is very high (OECD, 2000). If innovations cause severe job losses in individual regions and industries, people may become increasingly sceptical about the social benefits of technological progress and may demand a slow down of the innovation dynamic.

The micro-level analysis

It is evident that the nexus of innovation processes is the individual company, as it is there that the final conversion of knowledge into industrial innovation takes place (Haukness, 2000). And it is also on the company level where employment decisions are made. We will therefore turn our attention to the micro-level analysis, the relationship between companies' R&D investment, their innovation activities and their employment strategies. The following micro-level analysis is based on a company survey conducted in eight European regions.[1] We will first analyse the direct relationships between companies' R&D investments and the development of their turnover and employment. Introducing innovativeness as an intervening variable, we will analyse how R&D intensity impacts on companies' innovation activities and whether companies' innovativeness influences their turnover and employment.

Due to the powerful effect of the business cycle in the time period in question we can expect to see no statistically significant relationships between companies' R&D spending and employment evolution. In 1990 Europe was near the peak of the business cycle, whereas in 1995 it was still climbing up from the 1992-94 slowdown. Taking into

Process innovations allow existing products to be produced more efficiently, and hence often with less labour; whereas product innovations allow new products to be brought to market, enabling companies to expand and create more jobs

It could, however, be argued that if companies failed to implement process innovations they would lose competitiveness and possibly be driven out of the market altogether, with the consequent negative impact on employment

Clearly, it is extremely difficult to estimate potential employment effects of investment in R&D, as the relationships between research, innovation and employment are very complex

Table 2. Introduction of innovation by R&D intensity (%)

	R&D budget intensity				R&D personnel intensity			
Introduction of innovation	**Low** $x \leq 1$	**Medium** $1 < x \leq 4$	**High** $x > 4$	**Total**	**Low** $x \leq 3$	**Medium** $3 < x \leq 10$	**High** $x > 10$	**Total**
Introduction of innovation new to the company	**Low**	**Medium**	**High**	**Total**	**Low**	**Medium**	**High**	**Total**
No	32	13	11	20	29	9	14	19
New product	26	39	35	33	25	36	39	32
New product and new process	30	43	49	40	35	51	41	41
New process	[illegible]	[illegible]	[illegible]	[illegible]	12	4	6	8
	[illegible]	[illegible]	[illegible]	[illegible]	100%	100%	100%	100%
(N)	[illegible]	(110)	(156)	(438)	(192)	(124)	(132)	(448)
Introduction of innovation new to the market	**Low**	**Medium**	**High**	**Total**	**Low**	**Medium**	**High**	**Total**
No	62	46	33	48	60	44	42	50
New product	26	36	43	34	25	36	36	32
New product and new process	7	12	17	12	8	14	14	11
New process	6	7	6	6	7	7	8	7
	100%	100%	100%	100%	100%	100%	100%	100%
(N)	(178)	(110)	(156)	(438)	(192)	(124)	(132)	(448)

It is often argued that companies do not install R&D capacity to create their own knowledge but to be able to make use of external knowledge. Without such absorptive capacity, (Cohen and Levinthal, 1990) companies would not be able to benefit from external knowledge. On this view, companies' innovation activities very much depend on whether they have access to external knowledge and whether they are integrated into the knowledge flows between the different types of knowledge producers: companies and support organizations, including universities.

Of the companies with virtually no cooperation at all with other firms, about one in three did not introduce any innovation –whether new product nor new process technology– during the three year period (1993-1996). In the group of companies which had intensive cooperation with others, only 12 per cent were not innovative during this time period, while every second company in this group can be characterized as highly innovative, as product and process innovations took place concurrently. If we look at only those innovations which are new to the market, the trend persists, but of course the share of non-innovative firms increases in both groups. These figures also tell us that cooperation with companies is more important when it comes to gradual improvements, which are new to the firm, than for innovations that are new to the market.

It has been argued that companies do not install R&D capacity to create their own knowledge but to be able to make use of external knowledge. Thus companies' innovation activities very much depend on whether they have access to external knowledge

Table 4. Turnover and employment growth 1990–1995 brought by the introduction of innovation (%)

Turnover and employment growth	Introduction of innovation new to the market				
	No	New product	New product and new process	New process	Total
[illegible]	[illegible]	[illegible]	43	[illegible]	[illegible]
[illegible]	[illegible]	41	[illegible]	41	[illegible]
T+&E-	29	25	17	26	26
T-&E-	21	15	14	11	18
(N)	(232)	(145)	(42)	(27)	(446)

companies that have introduced both product and process innovations.

As indicated above, due to the powerful effect of the business cycle in the time period in question we can expect to see no statistically significant relationships between companies' R&D spending and development of employment. Our empirical findings confirm that, and hence we cannot test for this relationship in a direct and meaningful way. We can, however, assume that those companies that manage to transform their own, as well as external, knowledge into new innovations are also successful in improving their turnover and increasing employment.

Conclusion

Concerning our main question whether increasing public R&D funding can increase competitiveness and employment, targeting of R&D funding is the key: if funds are badly allocated, the contribution of R&D to growth and employment is likely to be negligible. Therefore, policymakers have to find out where it is most efficient to place R&D investments and how to improve conditions for the quality of publicly financed research.

Our findings on the micro level suggest that innovation policy could usefully encompass facilitating the incorporation of publicly financed R&D results in companies' innovation processes. Clearly, companies seldom innovate in total isolation; the companies tied up in inter-organizational knowledge flows are much more likely to innovate than the ones that do not cooperate with other knowledge producers. Moreover, cooperating companies themselves have to invest in R&D to develop their absorptive capacity. There is, we can conclude, a role for innovation policy focusing on facilitating network-creation (Schienstock and Hämäläinen 2001), so as to bring together companies with complementary knowledge and other knowledge producers, including universities in particular. Organizational innovation, and the stimulation of innovative networks can bolster the impact of employment enhancing policies.

Our empirical findings suggest that those companies that manage to transform their own, as well as external, knowledge into new innovations are also successful in improving their turnover and increasing employment

Innovation in the Service Economy

Ian Miles and Bruce Tether, *CRIC*

Issue: Services are the largest contributors to output and employment in industrially advanced countries. They have typically been seen as innovation laggards, whose new techniques and technologies mainly derive from manufacturing industry. However, software and telecommunications, through to banking and retailing, services have been shown to introduce their own innovations. The Community Innovation Survey (CIS) lets us examine some of the features that services innovation shares with that in other sectors – and where it diverges. Contrary to received wisdom, many services do undertake Research and Development, even if the structure of their innovative activities is often distinctive.

Relevance: The instruments and policies developed primarily for manufacturers may not be equally relevant to services. Indeed, the study of services innovation suggests that established approaches do not always do justice to many types of innovative organization – public agencies and smaller firms, for example – and to many types of innovation – for instance organizational and service innovation.

The services economy

The 'service(s) sector' was originally defined by economists in negative terms. It was the residuum of 'unproductive' activities– not accounted for by the primary (extractive) and secondary (manufacturing and physical production) sectors. But this residual sector has now grown to dominate employment and output in most industrial countries, and can be seen to contain several very different types of activity. Some effect physical transformations in the state of the material goods produced by primary and secondary sectors, and in the environments that they have affected. Some services deal directly with people, whether affecting them physically (transport, surgery, hairdressing) or in social and psychological ways (entertainment, education, counselling). Yet other services are involved in the production and transformation of symbolic material, that is information products (ranging from telecommunications to consultancy, from software to news services). Moreover, many services engage in multiple transformations; cosmetic surgery, for example, transforms the patient both physically and psychologically; education processes information and transforms people.

Many commentators have sought to find elements common to service activities. Many features

The services sector was originally defined in negative terms as everything not accounted for by the 'productive' primary and secondary sectors. Today, however, in advanced industrial economies it accounts for the largest share of output and employment and covers a wide range of activity

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retailing, hotels, restaurants, etc.) as well as micro-businesses and very small firms (which are very important in most services). And since the innovation indicators it uses were designed with manufacturers in mind, they may fail to capture services innovation adequately.

Tether et al. (2001) present a detailed analysis of services innovation based on the CIS2 surveys, conducted in 1997 across the EU. Just under half of the services firms covered reported undertaking innovative activities between 1994 and 1996 – slightly below the figure for manufacturers. But most service branches feature a high share of small businesses compared to manufacturing. (Financial services are an exception, dominated by very large firms). Since larger enterprises are generally more likely to engage in innovative activities, this might appear to be an explanation of the sectoral differences. Nevertheless, the difference in reported levels of innovation persists, even when size is controlled for statistically.

There are considerable variations between different services. Unsurprisingly, the proportion of innovators is highest amongst the technology-oriented services - their reported innovation levels are comparable to high-tech manufacturing. More traditional services appear to be particularly infrequent innovators. However, we should be cautious in accepting this finding at face value. Since the standard measures of innovation are problematic for services they are likely to lead to an under-recording of innovation in (traditional) services. Organizational innovation, and innovation through the use of technology, which are likely to be particularly important in services, is not fully examined by the survey (which focuses primarily on the production of new technologies). Service firms may not describe activities like software development as technology development (though technically these activities do fall within its ambit).

But even if we take the results at face value, they show that some services are highly innovative, whilst others are less so. Why should this be? Perhaps it has to do with the nature of the activities that are at the core of these services. One interesting line of enquiry would be to examine sorts of technology involved in the innovations reported. The CIS2, unfortunately, did not seek to investigate this, but a German services survey did. Licht and Moch (1999) confirm the centrality of new Information Technology (IT) to services - all of the innovating service firms in their German sample undertook IT innovations. Of course, many of them also applied other technologies, and new IT is certainly not the focus of all innovations. But IT does have a generic significance to services, in the same way that, for instance, motor and energy technologies do for almost all of manufacturing industry. This may be leading more services to be innovative – but learning rather than the passive adoption of technologies is involved, and there is also learning about how to be innovative.

Until recently, there were few generic technologies applicable to service activities. The high dependence on client interaction, and the intangibility of their products (particularly information products) meant that the application of technologies to their core functions was limited. Those innovations that did diffuse widely (e.g. telephones, typewriters, motor vehicles) posed relatively little technological challenge to service users. They featured relatively slow rates of change; they required relatively little configuration to meet the specific users' needs. We can reason then, that (apart from obvious exceptions – e.g., railways and telecommunications) few service firms needed to do more than acquire ready-made technology. This has presumably left many service firms with a low-tech heritage. Not requiring great levels of technical expertise to use the innovations competitively, they undertook little R&D and rarely established organized R&D management structures.

Until recently, there were few generic technologies applicable to service activities, and those that did diffuse posed relatively little technological challenge to service users. This has led to their being little R&D in the services sector and left services companies poorly linked into technological innovation systems also mean less systematic searching for innovation opportunities, and less learning from the experiences of others.

Of course, R&D is not the only innovation activity, and CIS2 allows us to examine a spectrum of such activities. This confirms that R&D is not strictly speaking the most common one, or the most important one for many services. *Acquisition of machinery and equipment, acquisition of other external technologies (including software)* and *training directly linked to innovation* were the most widely undertaken innovation related activities. This illustrates the importance of bought-in technologies (which overall is greater than R&D, and is also significant for the technology-producing services such as computer and technical services). It also indicates the significance of the human element for services. The distribution of expenditures among innovating firms spanned an immense range: amongst innovating firms the bottom quartile spent less than 0.33% of their turnover on innovation activities; the top quartile over 7%. Technology producing services tend to spend most on innovation, but all sectors surveyed contain some very high spending (and some very low spending) enterprises. Examining the breakdown of expenditures (where the data may be somewhat less trustworthy), on average, *acquired technologies* accounted for the largest share of expenditures on innovation whilst *in-house R&D* accounted for a quarter of total expenditures on innovation (this was higher amongst technology oriented services).

Another set of questions concerned sources of information for innovation. *Sources within the enterprises* were the most commonly cited, with about half the innovating service enterprises considering them *very important* (This was even higher amongst the large enterprises and amongst the computer, financial and technical services). A substantial proportion of non-R&D performing innovators reported that such sources (i.e. other than R&D) were very important for their innovation activities. This echoes accounts of professional knowledge, and knowledge gained from practice, as being important for services. Not surprisingly, given that one of the defining features of many services is their high level of interactivity with their clients, *customers* were the second most widely reported source of information for innovation - almost 40% saw them as *very important* (80% as at least *relevant*). *Competitors* are also significant as an information source (80% at least *relevant*, 20% *very important*), as are *suppliers* (20% *very important*). In contrast, the institutional structures formal of innovation systems - universities, research institutes and patents - were rarely seen as an important source of information for innovation. Even amongst computer service enterprises only 10% considered universities to be *very important*. But few innovators claimed to have been hampered by a lack of information about technologies, or about markets. It is unclear whether this reflects the ease of access to information or low expectations.

Cooperation and collaboration with other parties in innovative efforts can provide sources of information, finance, and access to technical resources and complementary assets. Only about a quarter of the innovating service firms actually engaged in collaborations to innovate –these were more often larger firms – though these were less inclined to collaborate than were large manufacturers. Technology producing services were also more prone to collaborate. Competitors and suppliers emerged as the most common external collaboration partners, being involved in about 40% of partnerships, while customers were engaged in about a third. (Perhaps competitors and suppliers come more to the fore in providing the technical knowledge needed in order to meet customer requirements, while customers are more central to supplying information as to what innovations are required.) *Consultants* and *research institutes* were partners to 30% of these enterprises, and a

Although services companies report much lower levels of R&D than their manufacturing counterparts, this may be partly due to the fact that services often fail to recognize their creative activities as R&D, and develop their activities and outputs on a project management basis

Firms in the services sectors appear to see internal sources, customers and competitors as being the most important sources of information for innovation, with universities playing only a marginal role of knowledge and good practices, supply of relevant skills, assistance with standards setting and qualifications, and better linkage into innovation systems, all need to be developed. Finally, it is vital to consider the ways in which other policy initiatives that bear on services may influence innovation in services. Regulatory reform, and changes in the market and governance structures of public services (which are often neglected in innovation studies and policy), and sectors like telecommunications and financial services, are liable to have considerable influence on innovation. Innovation is an issue that goes beyond policies for Research and Technology Development – and indeed, beyond the confines of innovation policy as it has conventionally been understood.

Keywords
innovation, services, R&D, soft technologies

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Contacts

Prof. Ian MILES, PREST, University of Manchester
e-mail: **Ian.miles@man.ac.uk**
Dimitris Kyriakou, IPTS
Tel.: +34 95 448 82 98, fax: +34 95 448 83 39, e-mail: **dimitris.kyriakou@jrc.es**

About the authors

Dr. **Bruce Tether** carried out his doctoral research at SPRU on the role of SMEs in innovation and employment creation by innovative SMEs. After some time working on similar topics at Warwick Business School, he joined CRIC at Manchester in January 1997, where he has undertaken statistical analyses of various innovation surveys, as well as studies of innovation in airports.
Ian Miles is Professor of Technological Innovation and Social Change at the University of Manchester, where he is among the directors of PREST (Policy Research on Engineering, Science and Technology) and CRIC (Centre for Research in Innovation and Competition). He was earlier a Senior Fellow at SPRU. His research interests include, in addition to innovation in services, Foresight studies and practice, and social indicators.

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