The Globalising Learning Economy

Implications for Innovation Policy

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The globalising learning economy: Implications for innovation policy

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Report based on contributions from seven projects under the TSER programme

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PREFACE

The European Union is mobilising considerable effort to cope with the major challenges confronting European society: in a context of increasing globalisation of the economic activities, the EU has to ensure the implementation of a sustainable economic and social development which takes account simultaneously of the need to create jobs, to strengthen the level of competitiveness of companies, to fight social exclusion and to ensure the protection of environment and the quality of life of its citizens. But, at the same time it has to anticipate and prepare for the needs for a new society based increasingly on knowledge and learning capacity of its citizens.

Socio-economic research, carried out at the European level through the projects financed by the Targeted Socio-Economic Research Programme (TSER) aims to contribute to the current debates on these issues, and to provide the European, national and regional decision-makers with new knowledge which could enable them to improve the definition and the implementation of their various policies.

This report is the result of a specific pilot action to establish the dialogue between researchers and decision-makers on the role that technology and innovation play in the economy.

Having as a starting point the work undertaken in seven current TSER projects, this action, directed by Professor Bengt-Åke Lundvall, brought together a group of researchers from different disciplines and schools of thought. Together with political decision-makers, they debated the results of their research and sought to find answers to, and new insights into the following questions:

- What is the impact on innovation policies as a result of the emergence of a global economy, based increasingly on knowledge and learning?

- What are the effects of globalisation, including European integration, on national innovation systems? Do innovation systems develop towards greater European integration or towards greater fragmentation?

- What are the mechanisms which allow a better design of research and development policies taking into account the phenomenon of globalisation and learning?

- What is the most suitable political level of intervention in this new context?

Conclusions stress the need for greater co-ordination of the various policies not only at the sectoral but also at the transnational level in order to better face the challenges of the globalisation. Stress laid on the co-ordination of the research, innovation and education policies supports the efforts of the European policy in these sectors which could find increased effectiveness if a similar approach were followed in the Member States. These combined efforts would certainly contribute to better preparing us for the requirements of the European society of tomorrow.

Foreword and acknowledgements

This report - a European Commission initiative - draws some provisional policy conclusions from the research currently being carried out in specific European projects under the Targeted Socio-Economic Research (TSER) Programme of the EU. In late spring 1997 the unit in charge of the programme in DG XII asked Professor Bengt-Åke Lundvall of Aalborg University (former Deputy Director for DSTI at the OECD) to take the lead in a pilot action to inform policy-makers of findings from seven ongoing TSER projects. This entailed two meetings with project participants and other experts, and more than 30 contributions from project members, and has resulted in the following report.

One basic objective of the exercise has been to provide policy-makers with a reasonably coherent 'world view' and with basic principles for policy-making on innovation in this new context. Another objective has been to point out research areas where more work is needed. These objectives have determined the process for producing the report, as well as its content and structure. The first meeting in Brussels (24-25 April 1997) gave us the opportunity to present TSER project co-ordinators and other invited contributors with a brief sketch of what we regard as the most salient transformations currently taking place in technological innovation at world level and in Europe. The participants suggested additional elements, features and corrections to this general framework, as well as a number of specific topics to be addressed in the report. With this as a starting point, the major lines of the report were drawn, and some of the participants agreed to write specific contributions.

The report has extensively benefited from these and other forms of contributions. Without them it would never have been completed on time nor in its current form. When writing/editing the report, we were faced with the difficult task of trying to fit in the different contributions we received, while following a coherent line of argument. It has not been an easy task, and we have undertaken major editing and writing in order to preserve the coherence of the overall report. This means that the report is not based exclusively on the preliminary results and findings of the TSER projects and that we have also used other references and sources.

A draft version of the report was submitted in mid-September. This served as a basis for a second meeting in Brussels (29-30 September 1997) with TSER project coordinators, and other invited experts, academics and national and EU policy-makers. The contents of the draft report were discussed, and the valuable and constructive comments made at these lengthy sessions served as input for the authors producing this final version.

Writing this report was possible only because of the collaboration and enthusiasm of many people, first and foremost the commitment and vision of Achilleas Mitsos, Miroslav Bures, Virginia Vitorino and Ronan O'Brien, who launched and supported this initiative technically by organising the meetings in Brussels and with whom we have had on-going communication.

We would like to thank all those who wrote special contributions for the report, namely Erik Arnold, Anthony Bartzokas, Patries Boekholt, Phillip Cooke, Johan Hauknes, Dylan Jones-Evans, Luis Sanz,

Gert Schienstock, Simone Strambach and Peter Wood. Without them this report would not have been possible.

Special thanks should also go to Daniele Archibugi, Kristine Bruland, François Chesnais, Jesper Lindgaard Christensen, Giovanni Dosi, Charles Edquist, Dieter Ernst, Jan Fagerberg, Dominique Foray, Paul A. Geroski, Ken Guy, Erik Iversen, Alexis Jacquemin, Andrew Jamison, Björn Johnson, David Keeble, Mikel Landabaso, Franco Malerba, Keith Pavitt, Mario Pianta, Sven Otto Remoe, Margaret Sharp, Keith Smith, Rolf Sternberg, Michael Storper, Morris Teubal, Bart Verspagen and Hans Westling, who kindly sent us recent published and unpublished material, as well as invaluable comments on our draft version.

We are also in intellectual debt to the many experts who commented the report in earlier versions at meetings and seminar. Still we are entirely responsible for the structure and content of the report.

Aalborg and Copenhagen

December 1997

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Susana Borrás

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Implications for Innovation Policy

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Chapter 1: Introduction[1]

The challenges of the globalising learning economy for innovation policy

One of the most fundamental trends in the economy over the last decades has been the accelerating rate of innovation and change, driven by intensified competition in many product and service markets. This reflects changes in sectors already exposed to international competition, and in those formerly protected. In other words, the faster rate of innovation and change is closely related to the transition towards a global economy that has been taking place since the 1970s. There is little doubt about the importance and great impact on national and local economies of today's closer economic integration in the form of trade, direct foreign investment, world-wide sourcing, inter-firm collaboration and, not least, the increasingly global markets for financial assets.

However, globalisation is not an automatic, unlimited and concluded process. Its real forms and limits are determined by phenomena, some of which are rooted in political decisions while others reflect technological developments. The globalisation of production, trade and financial markets are strongly interrelated to each other and to political decisions about deregulation and market liberalisation. There is also a strong mutual interdependence between globalisation and the development of transport and communications technologies. The tendency towards globalisation has created a strong demand for new communications technologies, and in turn the development of information and communications technologies (ICT) has helped to accelerate the process of globalisation itself.

Globalisation is, however, an asymmetric and unevenly distributed process. A closer look at flows of commodities and capital as well as of patterns of inter-firm co-operation points to the integration of multinational regions in America, Europe and Asia as the dominating aspect of internationalisation. And internationalisation and globalisation is more developed in relation to some factors than others. Nowadays, the global dimension of financial markets and flows is hardly questioned. The same can be said about trade in products and services, only to a lesser degree. The global dimension of other important factors of production, such as labour and technological know-how, is even more limited.

In any case, and despite these asymmetries, globalisation today has a direct impact on firms belonging to different industrial sectors and territories, through intensified competition. This means that economic performance in this new economic context increasingly depends directly on the learning ability of individuals, firms, regions and countries. Learning is necessary both in order to adapt to the rapidly evolving market and technical conditions and in order to achieve innovation of processes, products and forms of organisation.

One of the most important limits of globalisation is the spatial mobility of knowledge. While information and codified knowledge can be easily transferred across the globe at low cost, know-

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[1] There is no executive summary in the beginning of this document but the busy reader may turn directly to chapter 11 which sums up the main argument and the major results of the whole exercise.

how and tacit knowledge is not immediately transferable. In the learning economy crucial elements of knowledge remain specific and tacit, and rooted in specific organisations and locations. This is the basic reason why patterns of international specialisation in trade remain reasonably stable over time and why technology gaps persist between regions and countries.

Tacit versus codified knowledge – a crucial distinction for innovation policy

The distinction between tacit knowledge and codified knowledge is important because, if knowledge remains tacit, it flows less easily across organisational and geographical borders. If all knowledge were readily transformed into information to which everyone had easy access, there would be little incentive for firms, regions and nations to invest in R&D and technology gaps between regions and countries would be minor and temporary.

Basically, knowledge remains tacit if it is complex or variable in quality: in situations where several different human senses need to be used at the same time, when skilful physical behaviour is involved and when understanding social relationships is crucial. This is especially difficult to overcome when the context undergoes rapid change.

Change and learning are two sides of the same coin. Accelerating change confronts operators and organisations with new problems which demand new skills. The market selection of change-oriented firms further accelerates innovation and change. There is nothing to indicate that the process will slow down in the near future. Rather, the deregulation of product markets and the entrance of new competitors on to the world market will give new momentum to the process.

This is one reason why, over the next couple of decades, innovation policy will be crucial for economic performance. A major objective must be to contribute to the learning ability of firms, knowledge institutions and people, while at the same time coping with the possible negative effects of the learning economy in terms of social and regional polarisation.

One major result of this new economic context is thus that innovation policy is now more important than before. Globalisation, and especially the liberalisation of financial markets, has drastically limited the autonomy of general economic policies like budgetary and monetary policy. This loss of autonomy in trade, monetary and finance policy gives a more important role to labour market policy, social policy, education policy and, not least, innovation policy, as essential factors for guaranteeing sustainable economic growth under these new conditions. The increased importance of innovation reflects the fact that it represents a major response to intensifying competition by enhancing the learning abilities of firms and workers. Neither firms nor regions can establish sustainable growth without innovation and learning.

The scope of the challenges posed by the globalising learning economy requires that innovation policies should be reformulated to include a learning component. In the EU context there are two dimensions that should be carefully taken into account when discussing the contents of any new policy approach: in the first place, the horizontal dimension, whereby different policy areas should

be effectively coordinated to produce synergies to enhance the learning ability of the system; and in the second place, the vertical dimension of this coordination, where European, national and regional instruments and strategies are brought into line with this new approach, complementing and supporting each other in order to foster innovativeness throughout the EU.

Accelerating innovation and increased competition leave policy-makers with a complex task. There are three main lines of action that have to be taken into account when designing a broadly oriented innovation policy, namely:

1. Policies affecting the pressure for change (competition policy, trade policy and the stance of general economic policy);

2. Policies affecting ability to innovate and absorb change (human resource development and innovation policy);

3. Policies designed to take care of losers in the game of change (social and regional policies with redistribution objectives).

These policy areas need to be adjusted and coordinated horizontally in such a way that they promote innovation and growth without undermining social cohesion. This points to the need for horizontal coordination of sectoral policies that have traditionally been regarded as more or less independent. There is a need to create a minimum of congruence between these three sets of instruments. The weaker the human resources, the less efficient would it be to accelerate innovation. The weaker the innovation potential, the less competition the system can absorb. Competition policy might be regarded as an instrument for effectively speeding up change, but it must be tuned and adjusted to potential for innovation, human resource development and re-distributive goals.

The vertical dimension of policy coordination is also crucial. Since the mid-1980s, new policy instruments have increasingly been introduced at European and regional level to address technological development. This reflects the impact of political developments towards decentralisation and regionalisation in many national contexts, and the further development of the European integration process over the last 15 years. Each level of policy-making has tended to focus on the three different aspects of the policy moves towards innovation listed above. The new challenges posed by the globalising learning economy call for a reshuffling of policy responsibilities between local, regional, national and European levels. But, as we shall see later on in this report, this does not necessarily imply delimiting in exclusive terms policy actions only at one single level. (Some measures may effectively co-exist at the three levels, for example, the promotion of innovation networks). A crucial element is the development of mutual learning across the three levels, and the creation of institutions to gather a rich pool of policy insight.

Developing a new vision and policy paradigm

The challenges posed by the globalising learning economy need policy responses that are based on an understanding of the emergence of this new socio-economic and organisational context in Europe. In the recent past the EU, national governments, and regional and local authorities have developed new

policy instruments and reused old ones to tackle these emerging new challenges. However, in most cases this amounts to incremental adaptation of old policy instruments rather than the introduction of radically new mechanisms, and the response to the new trends is implicit and partial. It is useful, therefore, to try to provide a more comprehensive picture of what is going on in the field of innovation.

The aim of this report is to contribute to a new vision and policy paradigm at all levels of policy-making in the EU. By addressing some of the most salient aspects of the globalising learning economy and some of the most important policy implications, we attempt to bridge the gap between policy-makers and academics in the debate about the role of technology and innovation in the economy. This is an ambitious aim given the theoretical framework in which the notion 'learning economy' is embedded, especially as this framework is rapidly evolving. The differences in forms and styles of policy-making in Europe does not make the endeavour any easier.

The TSER programme launched by the European Commission provides a unique opportunity in this context. A number of on-going TSER projects address issues related to innovation, innovation systems and innovation policy in the context of broader socio-economic issues, and represent up-to-date and extensive academic research based on theoretical, empirical and comparative analysis. The current report draws upon the provisional results of seven different TSER projects: "Innovation Systems and European Integration" (coordinator Charles Edquist), "Technology, Economic Integration and Social Cohesion" (coordinator Bart Verspagen), "Regional Innovation Systems: Designing for the Future" (coordinator Phillip Cooke), "Services in Innovation, Innovation in Services" (coordinator Johan Hauknes), "The Strategic Role of Knowledge" (coordinator Peter Wood), "Networks, Collective Learning and RTD in Regionally-Clustered High-Technology SMEs" (coordinator David Keeble), and the project "Universities, Technology Transfer and Spin-off Activities" (coordinator Dylan Jones-Evans).

It is important to emphasise that the results referred to in this report are of a preliminary nature, since the research is still in progress. An evaluation of the full impact of the TSER programme (the final results of each project and their overall contribution to policy-making) is not intended. However, the empirical evidences, even though still preliminary, can contribute already to analysis of the innovation process and the impact of the globalising learning economy on European innovation policy.

However, the report is not based exclusively on the results of TSER projects as it also incorporates other sets of theoretical work and empirical evidence from important academic research. The aim has been to maintain a clear line of argument and cohesion in the report, while incorporating contributions and empirical studies from the seven specific projects where relevant.

This report is a hybrid product. It is neither a typical theoretical and academic document nor a typical policy report. Theoretical debates are not analysed in-depth and empirical data are presented in a condensed manner as illustrations and examples of the main arguments. On the other hand, the report does not give recipes for policies, with precise lists of policy instruments and action to be taken. Very little is said about policy implementation and the focus is on new policy principles rather than on designing specific instruments. We hope that, because of its hybrid nature, the report will be useful for both worlds: for the policy-makers, by providing a clear picture of the current changes in

the working of the economy and their implications for innovation policy; and for the academics, by providing something closer to a practitioner's approach and stimulating them to develop further the specific implications that their research can have on policy-making. Finally, it is up to the reader to judge if this kind of hybrid report is of any use.

It follows that the conclusions and recommendations in the report are no substitute for the process of policy deliberation and decision. Here, the practical experience of the policy-makers, their accumulated know-how from the implementation of previous instruments, and their understanding of the new socio-economic context must play a major role in identifying specific bottlenecks and problems in the system, and developing appropriate new instruments to tackle them. This is also true because the EU Member States are so diverse. The differences in terms of size, population, economy, etc. become obvious when examining the economic and institutional characteristics of the respective national systems of innovation. Innovative performance varies greatly across industrial sectors and regions in Europe. This diversity, and the many levels of government involved, means that it would be futile to present a comprehensive list of specific policy recommendations. Instead, the report aims to establish a common mindset that can apply across different policy areas and levels of decision-making. If this common mindset reflects a shared analytically-based interpretation of what is happening in the world, it will be a powerful tool for coordinating policies, horizontally across policy areas and, vertically through the different levels of government.

The contents of the report

The report is divided into three parts. Part I contains three chapters, which summarise the challenges raised by the current globalisation trends in the learning economy. Chapter 2 covers the major features of the globalisation process and the changes that have been taking place over the last two decades in relation to the innovation process. We argue that the role of tacit and codified knowledge in the economy deserves special attention as the basis for new transformations towards a learning economy. The modes of knowledge production and distribution have been changing, and tacitness is a key element in the effective exploitation of innovative opportunities, despite the growing importance of the trend towards codification, with the expansion of information and communications infrastructure.

Chapter 3 then considers the implications that these new trends have for policy design. It elaborates on the fact that a new rationale for public action is emerging in relation to a broader theoretical insight of the role of public actors in the system. Market failure is no longer the exclusive policy rationale: other complex and dynamic bottlenecks in the system need to be considered too. Of these, we pick out three different dilemmas, together with the question of social and regional polarisation in the learning economy. Taking this point further, the chapter states the need for a new policy paradigm based on the learning abilities of the system. Three main ideas are developed here: firstly, the need for policy strategies with an integrative and coordination-oriented perspective (horizontal and vertical coordination) which can create synergies through different policy mechanisms; secondly, policy should focus on institutional and individual learning, i.e. the primary goal of policy action should be to develop the learning abilities of the system; and thirdly, the new policy paradigm should recognise that policy-making itself should be a learning process.

Chapter 4 takes this point further. The new learning approach has essentially a systemic perspective where public action is one of a number of elements that define the peculiarities of the innovation process in a given territory. Consequently, the capacity of policy-makers and institutions to understand, adapt and anticipate policy demands by designing optimal policy instruments is crucial for the system's performance. This chapter summarises the nature of policy change and policy learning, and identifies three general ways of enhancing it in the area of innovation policy.

Part II of the report is the most extensive one, containing six chapters devoted to different specific aspects of the innovation process and of policy areas which influence them. Chapter 5 analyses the role of basic science and science policies in innovation systems. The interaction between basic science and innovation is complex and changes across scientific disciplines, technologies and industrial sectors. The chapter emphasises some overlooked positive effects of basic scientific research on performance, and especially science's contribution to the tacit knowledge base of the system by training students in scientific methods.

Chapter 6 addresses two crucial elements in the innovation system: organisational change and human resource development. Intensified competition forces firms and organisations to find new ways of doing things. Flexible structures within a firm mean that the firm becomes less hierarchically organised, that there is more interaction between departments, and that problem-solving is the predominant style. Similarly, human resource development is crucial for a firm's adaptability and learning ability. The human skills required are no longer exclusively 'technical knowledge' but rather a person's capacity to learn and to develop communication and co-operation skills. The chapter analyses the ways in which public policies can enhance both trends and how, through a 'new new deal', they can improve the learning ability of poor learners, who would otherwise tend to be excluded and marginalised in the learning economy.

Inter-firm co-operation and networks are other aspects of the new flexible mode of production, and are discussed in Chapter 7. Firms can no longer, produce the knowledge required to launch new products or production processes in isolation. Networks are forms of organisation in between market and hierarchy, and they are increasingly seen as interesting ways for policy-makers to enhance the strengths of the innovation system. This is why there has been an increase in the number of public actions at regional, national and EU level to enhance industrial networking in recent years. However, we point out that networks also mean costs for the individual partners and risks of technological lock-in for the system. Therefore public action should focus on those costs and risks as well, anticipating negative impacts and contributing to the renewal of networks.

There has been a general tendency in innovation studies to focus mainly on the manufacturing sector. Chapter 8 considers a different angle by looking at the role of the service sector, and more specifically the knowledge-intensive service sector, in the learning economy. Service firms are increasingly becoming powerful actors in the innovation process, as both producers and users of innovations. Knowledge-intensive service firms interact with all kinds of firms and play a special role in absorbing, transforming and distributing tacit knowledge in relation to technical and organisational change. The problems that the report identifies are mainly problems of access. Most clients of these service firms are large companies located in high-income and densely populated regions of the EU Public action should encourage the use of service firms by SMEs and in the less-favoured regions of the EU.

Chapter 9 focuses on procurement policy. This is a traditional means of public action, used by some countries to achieve innovation-oriented objectives not met when the market is left to itself. The US model, used mainly for defence contracting, is one of the best known. It has awarded contracts to firms and institutions to develop technologies and products not yet on the market, and has actively encouraged their dissemination for commercial purposes. Some European countries are successfully using this policy instrument to encourage innovators to produce energy-efficient, environmentally-friendly and other socially desirable products. However, this potential is still not exploited in other countries, and we conclude that the EU could play a more active role in encouraging the use of this instrument at European level too.

Chapter 10 examines the role of increased competition in accelerating the innovation process. Competition and co-operation coexist and there is a tendency for inter-firm co-operation to become more important as competition intensifies. The chapter argues that alliances are increasingly becoming more global and that EU firms should be given more encouragement to take part. It also argues that increased competition has important effects on social and territorial disparities, so there we need a broader definition of competition policy which takes this into account. The chapter concludes that there might actually be a strong need for global agreement to slow down the rate of change.

In Chapter 11 we sum up the report by presenting a skeleton model of the vision of the world that lies behind the whole analysis and we put forward some policy recommendations which we consider particularly important in the new context. We suggest two strategies for stimulating innovation: a narrow and conventional one, the main objective of which is to speed up the rate of innovation to strengthen European competitiveness, and another one that explicitly takes into account the costs of rapid change, including social and environmental costs. At the very end, we mention briefly some areas where we see a specific need for further TSER research.

PART I: Challenges Raised by the Globalising Learning Economy

Chapter 2: Globalisation and the innovation process

Introduction

Globalisation trends and significant changes in the innovation process are two parallel and interrelated phenomena influencing decisively the current context of the global economy. European firms, regions and states are obviously exposed to both, and are facing growing pressure from world market tendencies through more intense price and non-price competition. This applies not only to manufactured products, but also to the tertiary sector. As the report will show, services are also directly affected by these transformations and pressures, and in some cases simultaneously become agents of organisational and innovative change in the manufacturing sector.

As stated in the introductory chapter, the changes in these two important parameters of economic growth have important policy implications, especially for innovation policies at regional, national and European levels. However, before discussing the implications of the new scenario for innovation policies in Europe, we need to review the patterns behind these trends, by taking a brief look at the nature, complexities and limits of globalisation, and current changes in the innovation process. This review will lead later on in the chapter to a discussion of the gradual transformation of the European economy into a learning economy. Here, the key to economic performance is no longer a given knowledge base, nor information access capacities as such, but rather the ability of economic and productive actors to exploit these optimally by adapting rapidly to ever-changing market conditions and developing new capabilities as old ones become obsolete.

At the very end of the chapter we identify social and regional polarisation as the major negative aspects of the learning economy, with consequences for innovation policy. The acceleration of change reflects policies related to competition and trade, and in turn is reflected in social and regional polarisation that call for social and regional policies. Innovation policy affects the ability to promote and master change at company level, and we should therefore consider how it can be integrated into broader policy strategies, given the established division of policy responsibilities between regional, national and European authorities.

Major features and effects of globalisation[2]

Most scholars agree that developments from the 1970s onwards have provided greater impetus for transforming and globalising market transactions and industrial production. Different political and economic developments have determined the current configuration of the world economy and its on-going integration. The most salient *political events* of the late 1980s and all through the 1990s have related to the profound transformation of Eastern European political and economic systems and the dissolution of the bi-polar system, which have changed the dynamics of international politics. In the

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[2] Important aspects of the globalisation process are analysed in the Verspagen TSER-project on Technology, Economic integration and Social cohesion. See for instance Ietto-Gillies (1997).

aftermath of the Cold War there is a different political climate where new and old issues such as regional stability, the North-South divide, or the process of trade regionalisation acquire a different dimension. This change in the political climate and the current rapid trend towards globalisation since the mid-seventies are two deeply interrelated processes. This is not to say that there is a clear causal link between them, but merely that it is difficult to disassociate them in the macro-analytical and historical perspective of the last three decades.

The process of globalisation and market integration is also the consequence of some specific events in the *international political economy*. The liberalisation of trade and financial markets, important developments in transport and communications, and new rapid technological advances are the three elements most scholars use to identify the nature of globalisation, its limits and its implications for the wealth of nations. It is important to mention here the rapid growth of the Dynamic Asian Economies (DAE), which has significantly contributed to the pressure of competition on world markets. Our purpose here is neither to review the vast literature on this topic, nor to provide a new alternative insight into this phenomenon, but rather, to summarise the most relevant characteristics in relation to innovation. By examining the major features and effects of globalisation this section will serve as a basis for understanding the context in which important transformations of the innovation process has been taking place, and will discuss the role of innovation policy in wider policy strategies.

Market liberalisation and de-regulation

Two of the political and economic features that have most clearly marked the trend towards market globalisation have been the liberalisation of trade and of financial markets. These in turn reflect a broader political trend towards deregulation of national markets. However, there are important differences in the extent of liberalisation, and in the respective effects on national economies, which will become clear when we examine each of the two liberalisation trends.

Liberalisation of financial markets and capital movements has been one of the major political and economic processes in developed countries since the beginning of the 1980s. In previous decades, restrictions of capital outflows were generally argued in terms of preserving domestic savings for domestic use, and of reducing the risk of capital flight in times of exchange rate pressures. In turn, controls of capital inflows from abroad used to be justified for monetary control and non-economic reasons (as in the case of foreign acquisition of domestic enterprises). Starting with Japan and the UK in 1979, most other developed countries turned away from capital controls quite deliberately as part of a new policy strategy. As the OECD (1990) points out, the main goal of such initiatives was to allow domestic enterprises access to overseas investment capital and treasury operations, and to open up the financial sector to foreign competition.

Some specific international agreements and institutions, like the OECD and the EU, actively promoted this process. The OECD Code on capital market liberalisation had a dual effect since, by providing a 'barometer' of liberalisation measures, it encouraged cross-national comparisons indirectly influencing national practices and points of view. The EU move to liberalise capital movements operations by 1 July 1990 was an important step under the project to complete the Single Market by the end of 1992. The current political drive towards Monetary Union and a single currency aims at complete capital mobility in the EU.

OECD definition of liberalisation of capital movements:

Liberalisation of current invisible operations and capital movements means that residents of different Member countries are freely permitted by their authorities to conclude transactions with each other and that the corresponding payments may be transferred across the exchanges. In cases where a transaction does not require authorisation or where there is no transaction, the transfers are automatically free. Full liberalisation implies free competition on equal terms, without discrimination, in an international market that encompasses the OECD area. (OECD, 1990, p. 75)

Liberalisation in the advanced economies has tended to focus equally on capital inflows and outflows. Liberalisation has affected most significantly the admission of foreign securities on the domestic capital market, credit and loans, direct investment (in both directions, namely, the admission of FDI, and the permission to domestic companies to invest abroad), and the right of non-residents to repatriate funds invested in a country.

The deregulation of financial markets and the liberalisation of capital movements have gone hand in hand with an increase in the flow of foreign direct investments (FDI) and thereby contributed to globalisation (see Narula and Wakelin, 1997, for an analysis of US-investments). The impact of these changes on the economic process and on innovation may be quite radical. Deregulation may be regarded as a stimulus for international trade and foreign direct investment, but it may also be regarded as the strategic element in the construction of a new mode of capital accumulation dominated by finance capital.

The deregulation of financial markets and the liberalisation of capital movements have stimulated an increased flow of FDI and thereby contributed to globalisation, although the impact of these changes on the economic process and on innovation may be much more radical than is so far realised Deregulation may be regarded as a strategic element in the construction of a new mode of capital accumulation dominated by finance capital. One major element in the deregulation of financial market, the securitisation of treasury notes, had the side-effect of giving governments more freedom to run big deficits without risking inflation (Chesnais and Serfati, 1997, p.5). The resulting increased power of finance (rentier) capital is reflected in slow growth, high real rates of interest and stagnation in long-term investments in tangible and intangible assets (such as R&D). National governments do not dare to promote expansionary policies because finance capital can punish them by moving their assets abroad thereby attacking the currency rate. The dominance of passive-finance oriented ownership causes management to pursue short-term profit and neglect of long-term investment in R&D.

The globalisation of financial capital may thus have a detrimental effect on innovation. On the one hand, it helps to intensify competition by forcing firms to be constantly on the search for new innovations and to speed up the process of innovation. On the other hand, it tends to promote short-term profits in a context of depressed demand. The result of these combined forces may be faster movement along existing trajectories and in incremental innovation, while resources allocated to long-term efforts to create new trajectories and radical innovations are reduced. The result might

be as damaging as when land is overexploited and no new resources are added. According to Chesnais and Serfati (1997) the slow-down in the growth in business R&D-expenditure revealed in recent OECD-publications may be explained in this way. This potential for conflict between stimulating faster change along given trajectories and creating fundamentally new ideas will come up throughout the report as "the exploitation/exploration dilemma" (see Chapter 3).

As already mentioned, trade liberalisation was the other major international economic trend over the last two decades. The GATT Uruguay Round, concluded in 1993, included two important new features compared with previous rounds. First, it agreed to expand trade in manufactured goods; and second, it included areas which were previously excluded such as services, intellectual property rights and agriculture. The long negotiations centred mostly on questions related to domestic subsidies, non-tariff barriers, trade-related investment measures (TRIMs) and trade-related intellectual property rights (TRIPs), rather than exclusively on tariff structures for industrial products as in the seven previous rounds. Generally the round resulted in increased liberalisation of world trade, and most important, provided an opening for political negotiations in new areas.

However, despite the relative success of the last round, there are still remarkable disparities in the liberalising trends of different national economies. According to the OECD (OECD 1993b), since the launch of the Uruguay round in 1986, over 60 developing countries and former centrally planned economies have unilaterally liberalised their trade, but only 12 industrialised nations have responded similarly. Significant differences in liberalisation and protectionist practices have been revealed between developed and developing countries. The OECD report underlines the fact that the developing countries have increasingly engaged in liberalising policies, mainly because they are required to do so before applying for GATT membership. Developed countries do not find themselves in this situation, and their policies have continued to be based on protectionist practices. In this sense, argues the report, developed countries enjoy exceptional treatment.

Paradoxically, the formation of trading blocks and regional agreements has been taking place in parallel to the trend towards global trade liberalisation. The 1990s saw two important developments in this direction. The first was further progress with long established agreements such as the European Union, from the single market to the forthcoming monetary union. In Europe economic integration and political integration are two sides of the same coin, and the Maastricht and Amsterdam Treaty reforms marked a profound transformation of the political scene in Europe.

The second development was the creation of new regional agreements between states with common geographical borders. NAFTA (Mexico, USA and Canada, 1994) and ASEAN (Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei and Vietnam, 1992) are both of a free-trade nature, while Mercosur (Argentina, Uruguay, Paraguay and Brazil, 1991) is a common market, based on customs union and some coordination of macro-economic and sectoral policies. There is still much disagreement about the consequences of this trend, and more specifically, whether regionalisation hinders or benefits the global liberalisation of trade. In any case, the constitution of trade blocks is today an important reality in the world economy, and their impact on the respective national economies depends on many factors, one of them being the nature and contents of the agreement itself.

Increased communication in the world market

By increased communication at global scale we mean the rapid and significant transformation of both infrastructure and technology for the transfer and exchange of information, and physical items like persons and goods. The relevance of telecommunications infrastructure, information technology and transport connections in today's world cannot be denied. The rapid development of their technological and physical infrastructure has been a key factor in the proliferation of global exchange since the 1980s. This section focuses on two of the most studied phenomena in this respect, namely, the development of *transport infrastructure*, and the development of *information and communications technologies (ICT) and infrastructure*.

There has been a substantial improvement in transport infrastructure over the last two decades. This is evident from the emergence of more direct and faster transport connections in most modes (rail, air, road and sea), and from the lower costs of all passenger and goods transport over the same period. The reasons for these developments are two important trends: firstly the rapid evolution of transport innovation and technologies resulting in better, faster and larger vehicles such as high-speed trains, mono-rail trains, faster boats and ferries, larger and faster commercial planes like Concorde or Airbus, and safer and more economical cars, all of which have simultaneously enhanced comfort and safety; and secondly, liberalisation of national market regulations (EIU, 1990).

These trends indicate that, today more than ever, accessibility is considered to be a key factor for economic development. The accessibility of people, production and markets depends not only on the geographical centrality of a given place within a 'centre' or pole of economic development, but mostly on having better and faster physical links between the place concerned and other regionally and internationally important economic locations. It is in this scenario of higher relevance of the 'accessibility' and 'connectivity' of a location, that new risks might emerge. The negative aspect of the positive trends defined above is that, the more costly and worse the transport connections to a location, the more problematic are its prospects for economic development. The risk of territorial isolation and marginalisation through lack of access to this new transport infrastructure is growing. This is an issue to which we shall return at the end of this chapter.

The second phenomenon briefly analysed here is the implication of the fast and impressive development *of information and communication technologies (ICTs) and infrastructure* in the international economy. Since the mid-1980s computing systems have dramatically transformed the work place and personal life. The rapid creation and marketing of new hardware have resulted in similarly rapid change in software products. The same can be said of telecommunication technology and infrastructures. The development of satellite communications, optical fibre, sophisticated antennas, and mobile telephones are central to these transformations. Technologies and infrastructures reinforce each other, and the combination of these two fast technological developments has resulted in new communication channels, namely electronic mail systems and the world wide web. The next major new wave will be in the field of multi-media, where there are many strong entrants investing substantial resources in what is regarded as a very promising market.

Some authors have described these developments with terms like 'third industrial revolution' (Castells, 1989) or 'information society' (Brotchie, et al 1987). The point of these notions is that information and communications technologies are profoundly transforming economic operations

(production processes and transactions) and life-styles. As we shall see later, ICT development has also been crucial in creating a new context for the process of innovation. ICT is a fast growing industry in itself, characterised by shorter product life-cycles and faster technological development. However, its impact on the efficiency of production depends on how far it is combined with organisational flexibility and new forms of management control within firms, as well as enhancement of human resources. Advances and increased productivity in the service sectors, in particular, depend on these ICT developments (Petit and Soete, 1997).[3]

The political decision to develop 'telecommunications highways' (the example of the EU), aims to respond to these trends and to anticipate higher demand for infrastructure networks and capacity. However, political concerns have also moved in other directions, namely the awareness of new risks of social and territorial exclusion on this basis. It is now generally assumed that the future of the 'information society' involves important problems of social polarisation between those social groups with the economic and educational resources to follow the fast track, and those without, who risk being marginalised.

The effects of globalisation

The globalisation trends examined above have social, economic, cultural and political effects, all of them deeply interlinked. This report sets out to examine the socio-economic dimension of these effects. For this reason it emphasises the process of market expansion and increased communications at world level.

One of the most widely accepted ideas about the economic effects of globalisation is that it has substantially increased market competition. The expansion of the market in products and services affects the number of buyers and sellers, and the competitive dynamics within each of these markets. It is important to remark here that not all product markets and industrial sectors are equally globalised. Some, like the electronics industries, are truly operating in a world market, but others such as professional services are only marginally affected by these trends. Similarly, labour mobility is still considerably lower than capital mobility.

The next sections will examine in depth the transformations taking place alongside these globalisation trends. It will be argued that globalisation has not only increased market competition, but has also transformed it into market competition based increasingly on knowledge and learning. This is explained by the importance of non-price factors in market competition, where the learning capabilities of firms in terms of producing knowledge, using it and making organisational changes play a central role.

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[3] The European High Level Expert Group on the information society led by Luc Soete has recently delivered a substantial report analysing socio-economic consequences as well as policy implications. The report is, of course, much more comprehensive than this one as regards the specific consequences of information technology. The policy recommendations cover a broader set of issues but where they overlap there is little conflict with the ideas developed here (CEC, 1997b).

This leads to transformations in the innovation process and its combined effects with globalisation. The innovation process has accelerated considerably during the last decades, together with the rate of technological change, a central element in economic development and industrial dynamics. We will not enter into a discussion of whether transformation of the innovation process is a cause or an effect of globalisation. As Stopford and Strange (1991) argue, irrespective of causal links, the new environment for competition is the result of all these changes, which are deeply interrelated and are taking place together within the same time frame.

Changes in the innovation process

The nature of the innovation process

What has changed in the 1980s? Recent interest in the nature of the innovation process is strongly related to studies that try to explain the new perception of the relationship between economic theory and technical change by emphasising different aspects of innovation as a complex, interactive, non-linear process. The old image of a lonely scientist in a laboratory discovering new things and applying them directly to the production of a new product is no longer considered realistic. Similarly, there has been an expansion in the activities understood as innovation, and it is now generally accepted that innovation not only comprises scientific research but all the different steps of the process - including organisational aspects - until a new product or production process has been launched on the market.

Definition of innovation: "In an essential sense, innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organisational set-ups" (Dosi, 1988, p. 222)

Two of the most salient features of innovation are uncertainty and cumulativeness. As Dosi states: "Innovation involves a fundamental element of uncertainty, which is not simply the lack of all the relevant information about the occurrence of known events, but more fundamentally, entails also (a) the existence of techno-economic problems whose solution procedures are unknown, and (b) the impossibility of precisely tracing consequences to actions" (Dosi, 1988, p. 222).

On the other hand, cumulativeness refers to the fact that technological change follows specific patterns, rather than just being random or simple reactions to market demands. Again, in this respect Dosi makes three points: "(i) in spite of significant variations with regard to specific innovations, it seems that the directions of technical change are often defined by the state-of-the-art of the technologies already in use; (ii) quite often, it is the nature of technologies themselves that determines the range within which products and processes can adjust to changing economic conditions; and (iii) it is generally the case that the probability of making technological advances in firms, organisations and often countries is, among other things, a function of the technological levels already achieved by them. In other words, technical change is a cumulative activity" (Dosi, 1988 p. 223).

It has also been stressed that the innovation process is an interactive process of a social nature (Lundvall, 1997b). Interaction takes place at least at three different levels, namely:

1. Interaction between different steps of the innovation process.

2. Interaction between organisations.

3. Interaction between different departments of the same firm.

At each of these levels agents and individuals communicate and co-operate. They need to develop a common language and modes of interpretation and, above all, trust in order to overcome some of the uncertainties characterising the innovation process (Lazaric and Lorenz, 1997). This is one reason why the learning economy cannot function without a minimum of social cohesion.

When considering the previous statements about the nature of the innovation process, it is necessary to question to what extent, and if so in which way, the globalising context of the last two decades has affected the innovative process. This report identifies four major trends:

- *Acceleration.* In general terms, technological change has speeded up substantially over the last few decades. This is mainly illustrated by the fact that the time required to launch a new high-tech product has been significantly reduced. The process from knowledge production to commercialisation is much shorter today. And product life cycles are shorter too (for low- and medium- as well as for high-tech products). The fast development and wide use of ICT has certainly played a key role in bringing about this change.

- *Inter-firm collaborations and industrial networks.* New products are increasingly integrating different technologies, and technologies are increasingly based on different scientific disciplines. To master such a variety of domains is impossible even for big organisations. This is also reflected in the costs of developing new products and systems, which have grown. Short product life cycles require a rapid entrance into all major markets around the world. Most firms (even the largest) do not have the capability or the resources to undertake such initiatives, and this is the main reason for the expansion of collaborative schemes for pre-competitive research and the growing importance of industrial networks.

- *Functional integration and networking inside firms.* Speedy adaptation and innovation gives the functionally integrated firm an advantage. Rapid transformation of new signals from the outside into action inside the firm can take place only if departments collaborate closely and employees engage in horizontal communication inside the firm. Flexibility, interdisciplinarity and cross fertilisation of ideas at the managerial and laboratory levels within the firm are now important keys for success.

- *Collaboration with knowledge production centres.* The increasing reliance on advances in scientific knowledge for major new technological opportunities has been an important stimulus for firms to collaborate with scientific centres like public and private laboratories, universities and other basic and applied research centres.

Behind these changes lie changes in the process of knowledge creation itself. As we shall see there is a complex mutual interdependence between the globalisation process and the nature of knowledge creation and learning.

Knowledge production and distribution in the new socio-economic conditions

The previous section examined the factors which explain the increased pace of technological change and innovation. These trends are embedded in a larger context, namely, the knowledge production process and its relation to economic activity.

The notion "knowledge-based economy" draws attention to the fact that since the post-war period the production process has increasingly relied on knowledge-based activities. The proportion of labour that handles tangible goods has become smaller than the proportion engaged in the production, distribution and processing of knowledge. The expansion of the "knowledge-intensive" sector vis-à-vis other routine and physical production processes seems to be one of the major trends in economic development in this period. We shall go on to argue that it is better to talk about 'a learning economy' than a "knowledge-based economy", since the high pace of change means that specialised knowledge becomes much more of a short-lived resource, and that it is rather the capability to learn and adapt to new conditions that increasingly determines the performance of individuals, firms, regions and countries.

Codified and tacit knowledge

When discussing the role of knowledge and knowledge production in economic activity it is important to distinguish between tacit and codified knowledge. This distinction goes back to Polanyi (1958/78) and relates to the degree to which pieces of knowledge can be written down and transferred (Lundvall, 1997b).

Codification of knowledge implies that knowledge is transformed into 'information' which can be easily transmitted through information infrastructures. It is a process of reduction and conversion which renders the transmission, verification, storage and reproduction of knowledge especially easy. As explained by David and Foray (1995), codified knowledge is typically expressed in a format that is compact and standardised to facilitate and reduce the cost of such operations. Codified knowledge can normally be transferred over long distances and across organisational boundaries (Foray and Lundvall, 1996).

In contrast to codified knowledge, tacit knowledge is the knowledge which cannot be easily transferred because it has not been stated in an explicit form. One important type of tacit knowledge is skill. The skilled person follows rules not known as such even by the person following them (Polanyi, 1958 p.49). Another important kind of tacit knowledge is implicit but shared beliefs and modes of interpretation that make intelligent communication possible. According to Polanyi, the only way to transfer this kind of knowledge is through a specific kind of social interaction similar to the apprenticeship relationships. This implies that it cannot be sold and bought in the marketplace and that its transfer is extremely sensitive to social context.

These distinctive features of knowledge as an economic resource determine the context in which the dramatic changes in knowledge generation and use are occurring. Central to these changes is a transformation in the character of society's store of knowledge, involving codification and techniques for using codified knowledge. We shall consider other aspects of the economics of knowledge in Chapter 3 when we discuss the validity of neo-classical and evolutionary/structural approaches to the learning economy.

Intensified codification trends

The fast development of information and communication technologies gives a strong impetus to the process of codification by increasing the economic value of codified knowledge. Most knowledge, which can be codified and reduced to information, can now be transmitted over long distances at very limited cost. This in turn makes more attractive the allocation of resources to the process of codification.

Simultaneously, certain stages in the innovation process are characterised by the use of information technology and by partial codification. Testing and designing new products and processes can now be done with the help of information technologies. It has thus been argued that there is now an intensified knowledge codification process. What we are experiencing today, according to this view, is a process of faster and partial codification of knowledge into information bits, which as a result become easier to transmit to other people. This implies that the knowledge production process is accelerating along the lines of faster codification.

Codification is an important process for economic activity and development for four main reasons (Foray and Lundvall, 1996). Firstly, codification reduces some of the costs of the process of knowledge acquisition and technology dissemination. Secondly, through codification, knowledge is acquiring more and more the properties of a commodity. This implies that market transactions are facilitated by codification as it reduces the uncertainties and information asymmetries in transactions involving knowledge. Thirdly, codification facilitates knowledge externalisation and allows firms to acquire more knowledge than previously at a given (but not necessarily lower) cost. And finally, codification helps directly to speed up knowledge creation, innovation and economic change.

The limits of codification

In order to determine the limits to this codification trend it is important to realise that the mos important barrier to codification is change. Complexity may increase the cost of codification but thi might be overcome if the knowledge remains stable. There is thus a built in contradiction in th codification process. As certain elements of knowledge or processes of knowledge creation ar codified, the rate of change speeds up. This makes it less easy and attractive to codify other element of knowledge.[4] (The fact that some of the leading information systems producers such as IBM an

[4] An interesting issue raised by Cowan and Foray (1997) is whether and how far codification can handle some forms of incremental as opposed to radical change.

Apple have had such immense problems with managing their own businesses illustrates the fact that it is not easy to codify management behaviour in the form of expert systems in an environment of turbulent change.)

In fact, the clear distinction made above between tacit and codified knowledge may be misleading in some regards. Most codes relating to science, technology and innovation can only be decoded by experts who have already invested heavily in learning the codes. Tacit knowledge may be shared through human interaction and this may be the major force behind the formation of business networks. This means that codified and tacit knowledge are complementary and co-exist in time. It is the constitution of new ensembles of codified and tacit knowledge which is in question rather than a massive transformation of tacit into codified knowledge.

Therefore, there are two important limits to the codification process. First, the fact that codified and tacit knowledge are complementary and co-existing means that there are natural limits to codified knowledge. The main point here is that codification is never complete, and some forms of tacit knowledge will always continue to play an important role. And second, increased codification does not necessarily reduce the relative importance of tacit knowledge - mostly skills and capabilities - in the process of learning and knowledge accumulation. Actually, easier and less expensive access to information makes skills and capabilities relating to the selection and efficient use of information even more crucial than before. This means that tacit knowledge is still a key element in the appropriation and effective use of knowledge, especially when the whole innovation process is accelerating.

Knowledge creation and globalisation

Despite the previous statements, the distinction between tacit and codified knowledge is still important for understanding the nature of globalisation. In a hypothetical world where all elements of knowledge were transformed into general codes to which there was equal access for everyone, globalisation would be extreme in all economic activities and the only reason to specialise in specific activities would be access to primary production factors and scale economies. There would be no poor regions or countries and experts would not earn more than unskilled workers. It would be an economy where there were no incentives to learn new skills or develop new technologies because there would be no mechanisms to appropriate the fruits of such investments.

It is obvious that the real world is very different from this model. There has been major investment in R&D activities, education and training in most OECD countries over the last two decades, indicating a focus on knowledge production to benefit economic growth. However, as we shall see later, social and regional polarisation between slow and fast learners also accelerated over the same period. This polarisation reflects an increase in the demand for skills rather than the opposite.

There are several reasons why codification does not have this major effect on the transferability of knowledge. The most fundamental one is the rapid rate of change. When the content of knowledge is changing rapidly it is only those who take part in its creation who can get access to it. This explains the territorial concentration of specific industries ('Silicon Valley phenomena' and also the specialisation of industrial districts in so called low-tech areas like furniture and clothing - Maskell,

1996). It also explains the formation of industrial networks and inter-firm alliances aimed at technology development.

The second set of factors has to do with the need to invest heavily in order to be able to absorb and decode codified knowledge. It may be true that codification increases the possibility of transforming knowledge into a commodity but the value of this commodity will be very limited for all those who do not have the necessary basis for understanding and using the knowledge. Communication between two mathematicians operating at different ends of the globe may be completely codified but of little value to the most people.

Techno-globalism, national systems of innovation and innovation policy

Recent work by TSER scholars has helped define the scope and depth of globalisation in the field of innovation. Globalisation of technology has covered three different categories - international *exploitation* of technology, technological *collaboration* and *generation* of technology- each of which has been carefully and empirically mapped.

The result is that the most pertinent and most rapidly growing form of globalisation is exploitation abroad of technologies generated in the home country. There is substantial growth in technological collaboration aimed at getting access to relative strongholds abroad. The frequency and the growth of global creation of new technology, where multinational firms locate their development of new products and processes abroad, remains relatively low compared to the other two forms.

The scholars conclude that national systems of innovation take on more rather than less importance in this context, and they demonstrate that these become more and more specific in terms of their technological specialisation. They also conclude that the agenda for active innovation policy is extended rather than made obsolete by these developments (Archebugi and Michie, 1995, Archebugi and Michie, 1997)

There has always been pressure for codification of skills and knowledge, as illustrated by Taylorist modes of work organisation and by the many attempts to create expert systems and Management Information Systems. The fact that more and more geographically dispersed economic activities are becoming interconnected may give further impetus to such efforts. But they will always run into the problem that as soon as they have partially succeeded in formalising a piece of knowledge – often at great cost – the circumstances will have changed and the formalisation may actually hamper adaptation to change.

The learning process and the learning economy

In a context of increased market competition and rapid innovation, firms are faced with non-price competition factors. This means that the most important factor for individual firms is no longer having a given set of skills, but rather being able to acquire new ones effectively. In this sense, learning has become the key to successful economic and market operations in recent years. A firm's capacity to learn and transform in this new context is a crucial competitiveness factor. There is a definite need to constantly rebuild the skills of the individual and the technological and organisational competencies of the firm.

This implies, of course, a broad definition of knowledge and learning. Wealth-creating knowledge includes practical skills established through learning by doing, as well as capabilities acquired through formal education and training. And it includes management skills learnt in practice as well as new insights produced by R&D.

The learning economy is not a high technology economy

Simply defined, a *learning economy* is an economy where the ability to learn is crucial for the economic success of individuals, firms, regions and national economies. "Learning" refers to building new competences and establishing new skills and not just to "getting access to information". (Lundvall, 1997b, p. 6)

It should be obvious, from what has been said so far, that the learning economy is not necessarily a high-tech economy. Learning is an activity which takes place in all parts of the economy, including so-called low-tech and traditional sectors. As a matter of fact, even in highly developed economies the learning taking place in traditional and low-tech sectors may be more important for economic growth than the learning taking place in a small number of insulated hi-tech firms (Maskell, 1996). The learning potential (technological opportunities) may differ between sectors and technologies but in all sectors there will be niches where the potential for learning is high. Finally, it should be noted that all workers have some skills and capabilities to learn, even those misleadingly called 'unskilled workers'. These remarks are intended to prevent misunderstandings of the learning economy hypothesis which might lead to neglect of the developmental potential of parts of the economy less intensive in their use of formally acquired knowledge.

As we mentioned at the beginning of this section, one alternative concept to 'the learning economy' is 'the knowledge-based economy' (OECD, 1996c). The most fundamental reason for preferring 'the learning economy' as the key concept is that it emphasises the high rate of economic, social and technical change that continuously underlies specialised (and codified) knowledge. It makes it clear that what really matters for economic performance is the ability to learn (and forget) and not the stock of knowledge.

The main reason why learning has become more important has to do with the dialectics between learning and change. Rapid change implies a need for rapid learning, and those involved in rapid learning impose change on the environment and on other people. We have argued that globalisation, information and communication technologies, and the breakdown of institutional barriers to change (deregulation and liberalisation of markets) have worked together to speed up change. This has created a selection environment which favours those organisations and individuals which are change-oriented and we have entered a kind of circular cumulative process which is self-reinforcing. According to this interpretation, international competition and new technological opportunities linked to information and other technologies have forced all those involved in increasingly global competition to respond to the acceleration in change and learning. For the single firm this is reflected in a faster rate of innovation and more generally in what is seen as an intensification of competition.

Social and regional polarisation

One of the principal consequences and risks of the learning economy is its tendency towards social and regional polarisation. The learning economy, if left to itself, gives rise to polarisation between sectors, regions and people through its impact on the selection of firms and human resources.

The learning economy is the most important factor behind the polarisation of labour markets observed in all OECD countries (see for instance the OECD Jobs Study; OECD,1994b). Slow learners are becoming increasingly marginalised in a market characterised by rapidly changing demand for skills. Learning takes place mostly in the work-place, and those with difficulties in finding a job in the first place might very rapidly miss opportunities for adapting to the changing requirements.

The technology gap within the EU

"Statistical analysis confirms that there is a 'technology gap' twice as great as the so-called 'cohesion gap' (measured in terms of inter-regional differences in income, productivity and employment) between the developed and the less developed regions of the European Union. Moreover, there are also factors that are tending to enlarge this gap: the increasingly scientific nature of technology, the mutual strengthening of the R&D and education systems of the leading countries, the reduction in the life cycle of certain technologies and the importance of quality infrastructure" (Landabaso, 1997, p. 3).

Similarly, firms respond to intensified competition (the most powerful selectivity mechanism through increased co-operation aimed at sharing tacit knowledge. This takes the form c technological alliances, formation of business networks and closer linkages between suppliers an customers. But firms with weak resources might tend to be excluded. This mechanism explains partl why the narrowing of regional income gaps -the 'cohesion gap'- has slowed down in Europe ov(the last decade. It has been demonstrated that a major factor behind regional disparities is differe access to knowledge and learning (Fagerberg, 1996).

There are no signs that these basic mechanisms will weaken in the future. If anything, the entrance of China and the Eastern European countries as more active players on world markets, and the trend toward deregulation of sheltered sectors will give new impetus to rapid change.

Policy perspectives

We have now examined some of the most fundamental features of the globalising learning economy, which is characterised by intensified competition in many product markets and faster innovation. Intensified competition stimulates effectiveness in production as well as incremental innovation but, as we have seen, it also has a negative effect on income distribution and access to jobs. This means that innovation policy cannot be pursued in isolation from broader social goals. As a minimum it has to be coordinated with other policies that affect the socio-economic dynamics of the learning economy.

Innovation policy: a definition

In this report innovation policy refers to elements of science, technology and industrial policy that explicitly aim at promoting the development, spread and efficient use of new products, services and processes in markets or inside private and public organisations. The main focus is on the impact on economic performance and social cohesion. Innovation policy has wider objectives than those of science policy and technology policy. In this report innovation policy includes policies which aim at organisational change and the marketing of new products.

Many other policy areas affect innovation. This is true of competition policy and macroeconomic policy, but it is also true of sectoral policies like environment, energy, transport and communications and most importantly it is true of human resource development policy.

In the context we have defined we see a growing need to develop more coherent policy strategies. Specifically we see a need to coordinate and calibrate three different policy areas:

1. *Policies affecting the pressure for change* (competition policy, trade policy and the direction of general economic policy);

2. *Policies affecting the ability to absorb change* (human resource development and innovation policy);

3. *Policies to help the losers in the game of change* (social and regional policies with redistributive objectives).

These policy areas need to be adjusted in such a way that they promote innovation and growth but avoid putting social cohesion at risk. This is fundamental in its own right but also because it is difficult to see how learning can thrive in a polarised society. This points to the need for horizontal coordination of sectoral policies that have traditionally been regarded as more or less independent. It

is important to note that this call for coordination is analytically based and is not just putting policy coordination forward as an end in itself.[5]

Four alternative policy strategies to cope with the polarisation generated in the learning economy

As a crude simplification and for pedagogical reasons four alternative strategies may be outlined:

- Promote rapid change and neglect the negative impact on social and regional balances (the neo-liberal solution).
- Slow down change in order to reduce the negative impact (the neo-protectionist solution).
- Promote rapid change while compensating the victims through social and regional policy ex post (the old new deal).
- Increase the capability to absorb change by focusing on the learning capability of the weak learners - people and regions (the new new deal).

It is not possible to argue scientifically that any one of these four alternatives is superior to the others. But analysis of the globalising learning economy indicates that the 'new new deal' may be the only alternative sustainable in the long run. If successful, it increases economic welfare while at the same time increasing social cohesion and the learning capability of the whole economy.[6]

The three kinds of policy packages referred to (pressure, capability and compensation) can be combined in different ways as illustrated in the box above, and the specific combination tends to define four different major political strategies and ideologies. Any pragmatic policy strategy will include elements from all the four lines of action outlined below. But we believe that there is now a need to reorient policies towards what we call 'the new new deal' in Europe in order to overcome stubborn employment problems, slow productivity growth and social and regional polarisation.

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[5] The question of how to achieve horizontal co-ordination of these policies will be examined in detail in the concluding chapter of this report, Chapter 11, after an analysis of different policy areas in Part II of the report.

[6] The new new Deal will be examined in depth in Chapter 11 in relation to the different policy areas of part II of the report.

Regional, national and European policy responsibilities in the learning economy

Since the 1980s there has been a process of decentralisation and internationalisation of policy actions devoted to innovation and economic development in the EU. Sub-national governmental and public bodies have tried to maximise the potential of their local innovative milieu to enhance their competitive position by making full use of the legal and political instruments at hand. Thus many EU regions and local governments have actively undertaken various policy initiatives devoted directly or indirectly to technological development.[7] These policy trends, together with the importance of the regional dimension in the learning economy are two strong arguments for looking at the emergence of regional systems of innovation in the EU, which influence and are in turn influenced by action at national and European levels (Sternberg, 1996a and Sternberg, 1996b).

The importance of the regional dimension

The question of geographical scale is crucial in the learning economy. As the previous chapter explained, territory and proximity play a central role in the genesis of tacit knowledge and in the capacity to exploit it. The region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilising effects of research institutions. The development of high-tech regions in different parts of the globe is a positive example of this trend.

As will be seen in Part II of this report, the EU has developed a number of policy actions which directly and indirectly stimulate innovation.

Parallel to these two trends at regional and European level, the traditional involvement of national governments in this area has been changing. This does not necessarily mean that national policies have been 'squeezed' in between the sub-national and supra-national levels with zero-sum negative effects. The national level still remains the most important public actor in this policy area, controlling important economic and legal resources.[8]

There is a need to foster vertical policy coordination in order to tackle more effectively the challenges posed by the globalising learning economy. Responsibilities for the three policy areas identified above - policies affecting the pressure for change, policies affecting the capability to absorb change, and policies aimed at caring about losers – are today located at different governmental levels. The EU level predominates in the first set of policies (e.g. trade policy, anti-trust and

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[7] For an analysis of regional patterns in Spain as regards globalisation and innovation see the two publications from the Verspagen TSER project: Molero (1996) and Molero and Buesa (1996). Similar patterns of decentralisation and regional activism were observed in the US over this period (Schmandt and Wilson, 1990).

[8] In Chapter 3 we shall take a closer look at how national strategies have absorbed some of the new ideas and results developed in academic research on innovation.

procurement legislation, and jurisprudence). EMU will concentrate macroeconomic regulation even more at EU level. Main responsibility for human resource development policy is at regional and national level, while Community initiatives are beginning to supplement national ones in the field of innovation policy. The national level has dominated the area of social and regional policy, but the Structural Funds play a growing European regional development role in terms of territorial redistribution.

This means, predominantly, that regulating the pressure for change has become a European responsibility while the ability to cope with change and the social problems it gives rise to remains chiefly the responsibility of the national and regional level. In the new context of the learning economy it is not obvious that such a division of responsibilities is sustainable in the long run. As social and regional polarisation becomes more serious, there will be growing demands on European authorities either to reduce the pressure for change (neo-protectionism) or to move much more decisively into innovation and human resource development policies (the new new deal).

This is the general context in which innovation policy has to be discussed and designed. Innovation policy needs to be thought of as an element in broader socio-economic strategies, and this is also a major reason why social scientists from different disciplines might help to inspire the policy-makers operating in this field. The structure of the TSER programme, which encompasses, social exclusion and human resource development as well as technology policy, is well suited to tackling these complex issues, but there are important barriers between disciplines that are not easy to overcome when designing and selecting research projects.

In the new context it is obvious that technical innovation is strongly rooted in social and economic structure. This gives the social sciences a prominent role to play through two mechanisms, firstly by analysing in depth the characteristics of the innovation process and the performance of given innovation systems; and secondly, by designing policy prescriptions.

- To understand innovation a broad set of social science disciplines are needed. The traditional approach of neo-classical economics where the focus is on market failure is too narrow. Evolutionary economic models may be more useful since they take into account learning, diversity and institutions, but they need to be complemented by behavioural and cognitive sciences in order to encompass all the implications of learning.

- Social sciences related to management and organisation theory become increasingly important as innovation policy needs to focus more on the organisational dimensions of innovation such as the competence of users, the functional flexibility of firms and the formation of industrial networks.

As explained in the introduction to this report, the TSER programme aimed to provide the tools for undertaking such an analysis at European level. This report is a step further in the analysis of Europe's technological performance with special emphasis on the policy implications raised by the increased globalisation of the economy and the recent changes in the nature of the innovation process.

Chapter 3: A new theoretical rationale for innovation policy

Introduction

In Chapter 2 we outlined some of the new challenges that innovation policy has to cope with and we emphasised the need to integrate innovation policy into broader policy strategies. In this chapter we focus more specifically on innovation policy, as such, and on how it relates to theoretical assumptions about the nature of the innovation process and the role of knowledge in the economy. As the focus, over the last decade, has moved from science policy with broad social objectives toward innovation policy, and more specifically its impact on economic performance, the connection to economic theory has become increasingly important. This chapter is about how different theoretical approaches – neo-classical or evolutionary structuralist - to economics affect the definition of innovation policy.

The previous chapter emphasised the significant acceleration in the rate of change and the new relationship between codified and tacit knowledge. These ideas were not developed in a theoretical vacuum. The understanding of these phenomena goes hand in hand with new analytical frameworks focused on economic change, and theoretical perspectives which are, in their turn, based on extensive empirical research. The empirical insights gained the last twenty years or so in the field of innovation research have played a major role in the formation of an evolutionary, historical and structuralist approach to innovation in its interaction with economic development.

Against this new theoretical background, policy-making has begun to take on new tasks and new roles. Public action is no longer exclusively based on the neo-classical assumptions of compensating for in-built 'market failures' and under-investment problems in relation to R&D efforts. The new rationale for public intervention goes beyond that, identifying other areas and forms of action on the basis of new and broader types of failures (technological lock-ins, systemic lock-ins, and so forth), trade-offs and dilemmas. It takes into account the interactive and systemic nature of innovation processes.

This chapter summarises some of these general tendencies and pinpoints their limitations in an attempt to indicate the need for a new policy paradigm more adequate to the challenges of the globalising learning economy. It explains why the predominating focus on problems of appropriation and spill-overs inherited from the neo-classical approach may actually hamper the understanding of the learning economy. In particular, it points to the need for public policy based on difficult trade-offs in areas like exploitation/exploration, integration/flexibility and diversity/homogeneity.

Economics and innovation policy

The link between economics and science and technology policy is neither simple nor direct. Some of the complexities arise from the fact that developments in science and technology have a much wider impact than those relating to economic performance. It would therefore be unwise to design policies guiding activities in this field exclusively according to economic principles. On the other hand, it is obvious that the linkage between technology and economic performance has become increasingly strong in the minds of policy-makers in recent years. To a certain extent this may be summed up as a

movement away from science and technology, and towards innovation policy, as described by Dodgson and Bessant (1996).[9]

There are at least two major reasons for the growing attention given to the economic impact of innovation. One is, paradoxically, the fact that the more or less automatic contribution to economic growth from technological progress - 'the residual' or the contribution to economic growth classified as 'total factor productivity growth' -suddenly fell drastically at the end of the sixties and the beginning of the seventies. When the contribution of new technology diminished in spite of dramatic progress in information technology, policy makers asked for explanations and thereby created a demand for new analysis. A second, more recent factor is the end of the cold war which, together with globalisation tendencies, brought national economies into more direct confrontation on trade and foreign direct investment issues. These changes have moved the policy focus towards intra-capitalist struggles about competitiveness and growth and here especially the dramatic breakthrough of Japan and the Asian Tigers in information technology pointed to technology as a key factor for competitiveness.

Many policy-makers in the field of science, technology and innovation have only a superficial understanding of economics and operate mainly on the basis of common sense and intuition, and by copying what others are doing abroad. But they compete for public funds with other important public activities. In periods of public financial restraint they have to be able to argue their case with the economists at Ministries of Finance. In some countries the growing realisation that innovation is a key to economic growth has shifted responsibility for innovation policy to the Ministry of Finance (Netherlands), and in other countries the ministries in charge of economic affairs have given the issue greater attention than before.

The point is that policy-makers are increasingly under the influence of economic theory and that the distance between new theoretical results and new policy ideas has been shrinking. Still, we shall argue that there are still major lapses in adaptation that may result in serious misinterpretations and mistakes. First, it is a fact that most of the economists now working in Ministries of Finance were trained in a version of neo-classical economics that systematically misspecified the role of technology in their models. Second, we would argue that the old dominance of neo-classical economics has a negative impact upon the policy debate through its lasting imprint on terminology and conceptual frameworks. Concepts such as market failure, externalities and spill-overs tend to focus the attention on just one side of the learning economy and hamper our understanding of the new economy where networking, interactive learning and communication are absolutely central. The results of the TSER projects covered by this exercise all tend in different ways to confirm this general point. Some of them explicitly confront this perspective, while others prove that the crucial new phenomena

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[9] As they put it, "innovation policy is different from 'science' policy, which is concerned with the development of science and the training of scientists, and from 'technology' policy, which has as its aims the support, enhancement and development of technology, often with a military and environmental protection focus" (Dodgson and Bessant, 1996, p 4). Innovation policy takes into account the complexities of the innovation process and focuses more on interactions within the system.

analysed can be tackled more successfully using other conceptual schemes. One way to overcome this situation would be to follow the recommendation of Christopher Freeman and reinforce co-operation between economists working on innovation and representatives from other disciplines in social science (Freeman, 1994).

Neo-classical theory and technology policy

Until quite recently, when the new trade and growth theories appeared, neo-classical theories of economic growth and international trade treated technology as an exogenous variable. This is surprising given the results obtained by the first systematic attempts to measure the contribution of technological progress to economic growth on the basis of neoclassical models. These demonstrated that more than half of US economic growth could not be explained by the growth in labour and capital inputs, so this 'residual' was given the name of 'technological progress' (Solow, 1956 and Solow, 1957). In the theoretical models technology is assumed to come as 'manna from heaven' and everyone has equal access to it. In the predominating Heckscher-Ohlin models for foreign trade, firms in all countries have the same access to the global pool of blue-prints.

If these theoretical generalisations reflected what is going on in the real world, there would be little innovation in the private sector. Why should a firm invest in developing a new blue-print if it could be copied at no cost by its competitors? Innovation would be accidental rather than systematic and R&D laboratories a serious waste of money, possibly reflecting the vanity of capitalists. Some neo-classical economists, especially Kenneth Arrow and Joseph Stiglitz, have emphasised the discrepancy between model conclusions and real world developments and have made important contributions to the understanding of the economics of technological change. But their contributions have been for the sophisticated few and the impact on standard economics, as reflected in US university economics text books, has been marginal.

If all relevant technical knowledge were a public good – a good to which everyone has equal access - there is an extreme case of market failure that can be defined as a 'positive externality', or in more recent jargon as 'complete spill-over'. In the neo-classical world this would constitute a situation where governments ought to intervene to support production of the knowledge (either through subsidies or through own production in public organisations such as universities). The production of the commodity ought to be stimulated until the increasing marginal cost corresponds to the social marginal return or until the rate of return on investment in knowledge corresponds to the rate of return on alternative productive investments.

According to Arrow there are three interconnected problems relating to the nature of knowledge that give rise to market failure and call for public action:

- lack of appropriability (it is difficult to create a market for knowledge since the producers of knowledge do not enjoy it in exclusive terms);
- uncertainty (in the process of knowledge production, outputs are not predictable from inputs);
- indivisibility (and economy of scale in producing knowledge).

But if the full message of neo-classical modelling were taken seriously this active role of national governments would not be obvious. If the axiom of trade theory that technology is a free commodity at world level, and can be moved without costs across national borders, were correct, only naïve governments would use tax-payers' money to support the creation of new technology. The 'free-riding', non-interventionist governments would just leave it to their domestic firms to tap into the free pool of global knowledge. This argument might be less strong in a large technologically leading country such as the US, but policy-makers in the rest of the world could save a lot of national resources by not engaging in active technology policy. This kind of argument is now reappearing in debates about 'techno-globalism' where it is assumed (wrongly - as we saw in Chapter 2) that national innovation systems have lost their rationale.

Of course, national governments everywhere did promote the production of knowledge in different ways in spite of the fact that the prevailing high theory did not give much of a lead as to why this should be done. This was because it was generally recognised, even among economists, that a lot of knowledge was embodied in people and that people tend to stay inside their national borders much more than capital and 'knowledge as information'. In the beginning of the sixties there was a flourishing literature on 'human capital' as a crucial element in economic growth. Therefore it was uncontroversial to invest in education and training at all levels from primary school to university. Also, many grand national projects, and especially the military, nuclear and space programmes in the US and elsewhere, meant vast public investment in technology and knowledge that was not intended to be freely distributed through a global pool of knowledge.

Only in Japan was technology policy explicitly committed to promoting economic growth through its impact on industrial dynamics in the private sector. Here policy makers selected strategic sectors with strong growth potential and technology policy became a major instrument in this context. An interesting interpretation of the success of Japanese industrial policy by Christopher Freeman is that– for rather odd reasons to do with the prevalence of Marxist economists in Japan - it was designed by MITI engineers rather than by economists in the Ministry of Finance, who were the losers in the battle on industrial policy design (Freeman, 1987).

We would still argue that the main problem of misspecification of knowledge in the basic neo-classical models was not the negative impact on investment in knowledge production, policy-makers found their own more or less good arguments to invest in universities and technologies. The major negative impact was indirect, through the formation of a world view that is still around and seriously hampers our understanding of innovation in important respects. In order to clarify this we need to return to a discussion we had in Chapter 2, and take a more detailed look at knowledge and learning in the context of market failure.

The economic peculiarities of knowledge and learning

Market failure in transacting codified knowledge

Almost without exception neo-classical theories treat knowledge as synonymous with information. This is also true for models where the technology created is presented as private property. In these cases it is assumed that there is a system to protect intellectual property such as patents or copyright. As explained in Chapter 2, what we called 'codified knowledge' may be equated to information and

defined as such by its transferability through information and communication networks over great distances. There is an enormous and rapidly growing amount of this kind of knowledge. The tendency is overload rather than scarcity. Just to find out – become aware of – what pieces of information that can be useful is a demanding task and more and more resources are allocated to do so (EU, 1997, p. 16).

But even if we become aware of a relevant set of information we cannot always get access to it because we need knowledge to use information. Codified knowledge does not mean free access – not even when there is no system of intellectual property protection. Giovanni Dosi gives a telling illustration of this point. He points out that while a document containing the latest Fermat theorem in mathematics may be regarded as highly codified and therefore as 'information', only a dozen or so mathematicians world-wide have the necessary background knowledge to find it possible and meaningful and to work through and evaluate it. Average people are more like the chimpanzee who, if very hungry, might possibly feel like eating the couple of hundred pages of manuscript full of mathematical symbols (Dosi, 1996, p.84).

This means that the effective demand for 'Fermat theorems' is rather limited. If it were a package requiring less extreme user skills, like Windows 95 for instance, the scale of effective demand would reflect how much users had, and planned, to invest in learning to master the programme. The general conclusion is that a lot of information relevant for economic development is neither completely private nor the opposite and that most information needs to be worked on in order to become useful. To take an extreme case, the phone book may be free, but even so you need to know the alphabet and how to use a phone before you get any value out of it. And even here there will be some (even if very small) search costs involved.

On the other hand, we also know that intellectual property systems are of quite limited efficiency in excluding imitators. Firms belonging to sectors where the degree of codification is high use patenting to a certain degree, while others use it much less, and in all sectors they are regarded as rather weak in protecting knowledge. This means that the elements of technology that are codified and take on the form of information remain partially excludable because others do not have access to the code rather than because they have been patented. The very act of patenting is in itself a form of codification or of making the codes more transparent. In this sense patents have a contradictory effect on the excludability of the information involved. These empirically based insights point to a different world from the neo-classical one, where information is either public or private property and where it is the design of intellectual property rights protection systems that makes it private.

Tacit knowledge and market failure

Returning now to the Dosi example, it is also important to note that what makes it possible for the few outstanding experts to decode the Fermat theorem is more than just an enormous amount of information accumulated in their heads. The experts are outstanding in their field because they have skills and competencies that cannot be codified, not because they have absorbed many bits of information. In science, as in business management, these skills are tricks of the trade that have to be learnt in interaction with more experienced colleagues and to be combined with creativity and imagination – elements of knowledge that remain tacit. This tacit knowledge cannot be bought off the shelf and while the services of the expert can be bought it is difficult to prevent others from

getting similar access to his or her skills. So far it is only in science fiction that mad criminals manage to get physical control of the brains of eminent scientists. Tacit knowledge, as such, is not a tradable commodity.

The classical examples of tacit knowledge quoted in the literature are typically individuals skills (like cycling and swimming) that cannot be made explicit and that cannot be transmitted through, for instance, telecommunication networks. But, it is interesting to note that this and other kinds of tacit knowledge closer to the economic process, such as management skills and economic competence, can be learnt. They will typically be learnt in interaction with other people, through a master apprentice or collegial relationship. This means that tacit knowledge can be shared through interaction and co-operation. Simple forms may be accessed through imitation of behaviour, but in most cases learning is greatly facilitated if the master or colleague co-operates with the apprentice.

On completion of a specific project people and organisations that solve problems together will typically, as an end result, now share some of their partners' original knowledge, as well as some of the new tacit knowledge produced by the interaction. Interactive learning is the key to sharing tacit knowledge, which means, of course, that the social context is important for this kind of learning – an observation which we shall discuss in more detail later.

Tacit knowledge is not to be found only at the level of the individual. An organisation, with its specific routines, norms of behaviour, codes of information etc. may be regarded as a unit that carries within it knowledge, a substantial part of which is tacit. Management may, from time to time, make attempts to codify everything constituting the organisation – perhaps in order to make it less vulnerable to the risk that key persons leave the organisation – but, if they are realistic they will realise that it can only be done in a very simplistic and static environment and that the efforts involved may bring the organisation in a stand-still while the rest of the world keeps moving.

Even industrial networks and inter-firm co-operation arrangements may be seen as repositories of tacit knowledge layered into common procedures and codes not reflected in formal contracts or other documents. Some of these procedures might be possible to codify while others would lose their meaning if they were written down. (Playing golf, drinking cocktails, flirting with professionals from another organisation, and sharing political, religious and literary tastes, may be fundamental in bringing people from different organisations together in projects of interactive learning but they do not look impressive on paper and they undermine their own function if they become part of an explicit and purely instrumental strategy.) This is a problem similar to the formation of trust in a market economy. Arrow makes the point that trust cannot be bought, and even if you could buy it would have no value whatsoever. There would always be someone around to pay more for friendship and trust relationships if they were for sale (Arrow, 1971). The informal and tacit character of 'know-who' kind of knowledge (Lundvall and Johnson, 1992) is crucial for the strength of networks.

A major reason why the neo-classical vision of the world is inadequate in the globalising learning economy is that the formation of and access to tacit and shared knowledge has now become the key to economic success. The process of interactive learning will not take place in pure markets where individually optimising agents meet; there will be no general equilibrium and the ability to learn is not the same across individuals and organisations. The learning process is socially embedded and organisational forms and institutional set-ups are crucial to the outcome of interactions. The next

section identifies those key characteristics of neo-classical economic theory that prevent it from providing a sound analysis of the learning economy.

The key characteristics of the neo-classical approach

The reason why neo-classical economics is focused on appropriability and spill-over problems is, of course, that all models in this tradition – including new growth theory and new trade theory – are based on optimising agents aiming at maximum profit or individual utility. This assumption is necessary to define another major characteristic of the tradition: the state of equilibrium. In order to determine what agents do it is necessary to know what returns they expect from investing in knowledge creation and in order to specify the returns it is imperative to specify the appropriability regime as either one of complete spill-overs or one of full appropriability. The most advanced new growth theories typically introduce a combination where part of the output is private property while another part is public (Verspagen, 1992, p.23 et passim).

Optimising and innovation

The assumption of optimisation in the context of innovation is of course highly problematic. Again, it is Kenneth Arrow who has pointed out that, in the case of a true innovation, those who start working on it will know in advance neither its technical characteristics nor its market potential. To refer to this as 'fundamental uncertainty' is an understatement; Keynes' allegory of 'expeditions to the South Pole' gets closer to the truth. All empirical studies on significant innovations confirm this. The first version of new product is primitive and reaches only a small group of users. Later on more sophisticated and less expensive versions develop and new markets open up. Firms with a lead in the technology may earn a lot of money but very few of them had any clear idea of what was going to happen when they introduced the first version of a product innovation.

Trying to apply the Friedmanite argument that those that survived a selection process, unconsciously, acted as if they had been optimising is not easy in the light of empirical evidence Many innovation managers confirm that their most successful innovations were made possible by the lack of control of management, by lax accounting procedures and by 'irrational' enthusiasm To argue that since they won the race, they were unconsciously doing the instrumental calculations not only reduces the whole argument to a tautology, but also misleads management students, who will try to do the right thing all the way through. Most innovation studies indicate that the new networking mode of innovation discriminates against firms that follow neo-classical rules and one-sidedly focus on their own profit maximisation; less structured patterns of behaviour tend to achieve more success in the innovation race (Storper, 1997).

Equilibrium and innovation

The idea that equilibrium models should be the standard tool in economics is also difficult to apply to innovation. The position of Schumpeter in his conflict with his mentor Böhm-Bawerk is still valid. According to Richard Goodwin, Schumpeter was excluded from Böhm-Bawerk's seminar for a long period because he argued that capitalism in equilibrium could not be viable. It is the constant creation of new ideas, products, services and needs that keeps the system moving, and if it ever reaches a state of harmony where nothing changes it would not be a capitalist economy anymore. The dynamic

version of equilibrium where these ideas, products, services and needs develop in such a way that critical growth rates and/or the proportions between inputs and sectors remain constant is quite different from anything witnessed in the real world. As pointed out and discussed in theoretical terms by Pasinetti (1981), growth and uneven development are two sides of the same coin.

Representative firms in the learning economy

The third characteristic of neo-classical economics that needs to be considered is the use of 'representative agents'. All firms, including the local hot dog stand and General Motors, are assumed to follow the same basic rules when making decisions. These abstractions are motivated by the quest for a "general theory" of economics and for reasons of parsimony. If it were accepted that agents differ not only in regard to their skills, access to information, and capability to learn, but also as to how 'rational' they are, it would be difficult to come up with precisely defined states of equilibrium.

This abstraction is a serious problem, however, when the area of study is innovation and change. In principle it is possible to assume that innovation is a process where the outcome is determined exclusively by a combination of the effort made and chance, and that all firms have the same probability for success. Most innovation studies show that this is not a realistic assumption. Path dependency and the cumulative character of knowledge give different firms very different starting points. There are marked differences between firms belonging to the same sector, both in the forms of organisation used and in performance in terms of learning and innovation. To disregard these differences prevents the analyst, and the policy maker, from observing and analysing a rich unexploited source of productivity growth (Andreasen et al, 1996).

Another important result of innovation research is that the basic characteristics of the innovation process differ from sector to sector (Pavitt, 1984). For instance, it is now well established that the role of science and learning by doing differ between specialised supplier firms and science based firms. To model average conduct is not recommendable. In the field of innovation, models have to be explicit in recognising the coexistence and interaction of agents with different patterns of behaviour (Cohendet and Llerena,1997). This is not just a call for more realism. Overall innovation performance in an economy depends on how sectors with different modes of behaviour interact. To disregard such differences is to disregard information of fundamental importance for policy design.

Learning in the neo-classical model

Neo-classical analysis assumes that agents remain the same in crucial respects (preferences, competence and rules of behaviour) throughout the process being analysed. Very little room is left for agents to learn new rules of behaviour and new skills. Bayesian learning leaves room for simple adaptation based on feedback about the outcome of earlier action, but the basic preference schedules remain unchanged and so does the 'rationality' of the agent. The state of general equilibrium around which neo-classical economists build their models may be described as a state were there is no need and no incentive to learn. All expectations are fulfilled and "business as usual" is the best kind of rule to follow. We have already pointed out that knowledge and information are treated as one and the same in the neo-classical models, so the closest we get to something called "learning" is "information acquisition". The fact that most economically useful kinds of knowledge have a tacit dimension and

that such knowledge only can be obtained in a social process of interaction is completely disregarded.

Market failure in the learning economy

Even among economists working within a different paradigm than the neo-classical, basic concepts of market failure, externalities and spill-overs tend to monopolise much of the innovation policy debate.[10] Here we shall argue that there are other concepts more relevant to understanding the learning economy.

The problem with using the market failure concept in the context of the learning economy is that almost all aspects of knowledge creation and learning are characterised by market failure. Information (we shall come back to tacit knowledge below) is difficult to trade in a market because of its inherent characteristics.

- It is difficult to arrive at a price since the buyer does not know what he/she is getting, and if he/she does know he/she does not want to pay for it.

- Even if you sell information you keep it and it is difficult for the buyer to get guarantees against a sale to potential competitors.

- Information may be costly to produce but the marginal cost of copying it is negligible (to use it intelligently is not always easy though).

- Information is not scarce, but the ability to locate it, select it and use relevant parts of it is scarce.

- Typically this ability will grow when you use it; the more you use the resource the more you get of it.

These characteristics make information/codified knowledge a very peculiar commodity and all transactions involving it will be characterised by elements of 'market failure'. Tacit knowledge is plain market failure in the sense that it cannot, as such, be transacted in the market. Normally you can get access to it only by entering into a process of interactive learning. This being the case, we can conclude that market failure is not a useful concept in the learning economy. Since this applies wherever innovation policy matters it gives little help in locating a need for policy.

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[10] See for instance Lipsey and Carlaw (1996). Here the whole argument is built around the concept of spill-overs, while the content is actually about many other interesting problems, like mismatches between technology and social structures.

Spill-overs in the learning economy

The concepts of externalities and spill-overs take as their starting point the idea that all knowledge is originally produced by one individual unit and that a main concern for the producer is to avoid others getting access to it. This view is biased since, in the learning economy, networking, co-operation and learning-by-interacting are necessary elements in most successful strategies.

It is true that agents try to keep some strategic information for themselves in specific situations and from time to time some of them even enter law-suits when their property rights have been illegally infringed. But they also enter into a complex set of relationships where the aim of the network is to create new knowledge, to share and pool different elements of knowledge and to stimulate the spread of knowledge to as many users as possible. In all these relationships the main focus of the agents is not on hindering access by others to their knowledge but rather on creating a relationship that makes interactive learning possible. This implies that instrumental behaviour will become mixed up with 'communicative rationality' where the common goal is for partners to understand better what the problems are and what solutions can be developed (Lundvall, 1992).

This implies that the rationality determining what agents do is context-specific. The academic professor who tries to sell his/her knowledge to students in order to maximise his income will found it difficult to survive, because learning does not thrive in a context of individual optimising. Quality control would be undermined in such a system. In general, honesty is fundamental for the quality and efficiency of academic knowledge production. If a professor systematically steals his/her colleagues' ideas and does not contribute his/her own ideas through open exchange in seminars he/she will be excluded from academic networks. It is obvious that academia is a world where pure instrumentalist behaviour does not pay, which is why there is a shared set of norms that people should be honest and open in their communication (this is not to say that real universities are purely oriented toward communication and have no instrumentalists in the staff). Let us now assume that the same university professor wants to sell his/her car on the open market. In this situation he/she might be less communicative, and would not feel a strong moral pressure to reveal more about the weaknesses of the car than is absolutely necessary to avoid a law-suit.

At the other end of the scale, there might be a company lawyer who is an expert in pursuing law-suits in intellectual property rights cases. His/her main concern will be that the firm does not give too much away in terms of information to competitors. Even so, he/she might regularly engage in a process of interactive learning with lawyers from other firms to find the right loop-holes in an interesting case – a phenomenon von Hippel (1987) calls "know-how trading". Our point here is that what you do and the context in which you do it will affect your rules of behaviour and even the rationale on which you base your behaviour. Engineers, technicians and others engaged in interactive learning in order to solve common technical and organisational problems will not be as instrumental as sales people and lawyers. They will promote rather than restrict 'spill-overs'.

New growth theory

New growth theory and new trade theory represent radical changes in the way technology is treated in neo-classical theoretical models, and technology is no longer exogenous in these models. There is a multitude of different models but they all regard technological progress and its impact on

productivity and economic growth as something to be explained within the model. Some models emphasise learning by doing (Romer, 1986 and Lucas, 1988a), others investment in human capital (Lucas, 1988b) and still others investment in R&D to devise new and more efficient production techniques (Grossman and Helpman, 1989, and Romer, 1990). Some of the technological knowledge produced is assumed to be protected private property while some is public information.

In order to include the specific characteristics of the innovation processes the models abandon some of the neo-classical standard assumptions such as increasing marginal costs and perfect competition, although they still retain the more basic set of assumptions discussed above: firms are still assumed to be homogeneous optimising units and the model is focused on defining a unique equilibrium path of economic growth.

One major conclusion from most of these models is that it pays an economy to have a large proportion of well-trained people in the labour force. Another major conclusion is that big systems grow more rapidly than small ones. If we compare these conclusions with historical and empirical evidence we find that the first conclusion is too simple since the ability to use human capital effectively is necessary in order to realise the potential. Investment in human capital is a prerequisite but not a sufficient condition for rapid economic growth. The second conclusion has been tested empirically by Fagerberg (1995), who found that it is true only for some specific sectors like cars, computers and electronics, while factors other than scale - such as investment in technology and wage costs predominate for most other products.

Nelson (1994) looks at the post-war history of thought on economic growth and shows that most of the ideas contained in both the old and the new growth theory were already present in the survey of economic growth made by Abramovitz (1952). The real mystery is why it took so long for neo-classical theorists to include them in their theoretical models and, according to Nelson, there are still important pieces of Abramovitz' analysis missing, especially the introduction of institutional factors. Nelson argues that the main impact of formally modelling what was already well known, was to legitimise the field of research and to attract young students to the field of growth analysis.

The focus on the appropriability and spill-over problem has remained central to the debate on technology policy, even in the context of new growth theory. New growth theory has developed the perspective and made distinctions between, respectively, 'excludability' and 'rivalry' of knowledge. According to this new interpretation, a significant proportion of knowledge is non-rival in the sense that its use by one agent does not undermine its usefulness for others, and part of it is excludable in the sense that others can be hindered from getting access to it whereas other parts are open to public access (Romer, 1986, and Romer, 1990).

New growth theory follows the neo-classical tradition in its strong assumptions regarding optimising behaviour. Agents are assumed to be homogenous and well-informed about the potential profitability of investment in 'new designs'. The analysis focuses on equilibrium paths of economic growth. The models assume all agents to be similar in terms of behaviour and competence. They treat knowledge as synonymous with information and there is no specification of the institutional context. So even if they, in some important respects, have brought the theoretical models closer to reality than the 'old' neo-classical ones they are not well-suited for tackling the problems of the learning economy. The advice they can offer to policy-makers is at best very general, and at worst misleading.

Policy-making in the old paradigm

This lack of precise information has not prevented the implementation of specific forms of policy intervention, based on techno-economic and political arguments, with a mixture of theoretical and practical considerations as inspiration. The common approach in the field, if not in all practical measures, was based on a linear model of innovation whereby investment in basic science was regarded as an input into technology development to be introduced later on by business. The further away from the market the more legitimate was government intervention. This led to certain types of bias in the strategies pursued. Technology policy concentrated on the production and to a lesser extent the dissemination of new knowledge, relying in the first place on the support of basic research. This strategy directly followed Arrow's assumptions of 'market failures' and corresponds to the old neo-classical model where the absorption of knowledge is without friction. In practice, technology policy has tended to pursue simultaneously two broad objectives:

- to support, enhance and accelerate the development and use of technology through financial measures

- to regulate the use and development of technology in such a way as to eliminate or minimize risks posed by technology to health, society and the environment (Braun 1994).

There are some exceptions where the state has traditionally been seen as entitled to extend its involvement in technological development to fields closer to the market. One case is large-scale technologies (known as "big" science) where the massive financial requirements resulting from technological and/or economic indivisibility exceed the capacity of private companies. This kind of market failure argument has been used to justify government intervention in technology fields like transport, space, nuclear energy and computers. A second argument for state intervention has been that of gaining and maintaining international competitiveness (Rothwell and Zegveld 1980). The state has often placed direct contracts with companies to develop specific technologies either through technological procurement policy, or through direct subsidies for specific R&D projects. A third powerful argument for state involvement has been the avoidance of technological dependencies. This argument is closely related to the second one, but has tended to justify support of applied research in the field of military technology.

New theoretical insights and macro-trends in policy action[11]

Implicitly the agenda for the new theoretical developments has been presented already by outlining the characteristics of the learning economy and the difficulties in understanding these through a neo-classical approach. The relevant contributions to a new theoretical understanding in this field are heterogeneous and come from different strands of thought. Here, we will start by indicating what we

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[11] This section is partly based on the contributions of Prof. Keith Smith (1997): "Systems approaches to innovation: Some policy issues" (unpublished paper) and of Prof. Franco Malerba (1996):"Public Policy in Industrial Dynamics: An Evolutionary Perspective" (unpublished paper) .

regard as the core elements (stylised facts) of the learning economy that have to be mirrored in the new theoretical perspective. These are:

- Innovation is not a marginal phenomenon in the economy – it is central to the industrial dynamics and growth of regions and nations.

- Innovation is an interactive process rooted in searching and learning. Interactive learning is socially embedded and there is thus no 'economic sphere' that can be strictly isolated from the social sphere. Institutions matter for conduct and performance.

- Agents differ in terms of competence and rationality and they change in these respects in connection with learning processes. Their ability to learn also differs, and reflects earlier learning as well as their ability to forget.

- Economic structural change reflects the transformation of agents and organisations on the one hand, as combined with a process of selection of agents and organisations on the other hand.

- The internal organisation of a firm and its positioning in innovative networks are crucial for the conduct and performance of the firm. Innovative networks also include knowledge-based organisations such as universities and laboratories.

- There are systemic differences between countries (and regions) in terms of broader social context, organisational forms and patterns of specialisation. National systems of innovation do different things and they do them differently.

One common characteristic of the new approaches is that innovation is perceived as a complex, interactive and open-ended process, with a collective dimension. It is essentially a process of learning, where formal and informal institutions play a major role. Knowledge is cumulative, building up from the knowledge base within given technological paradigms and along technological trajectories. Knowledge development is regarded as an evolutionary and path dependent process [12]

Major contributions to the understanding of these phenomena have come from:

- evolutionary economics (Nelson and Winter, 1982, and Andersen, 1994)

- institutional economics (Hodgson, 1988, and Johnson, 1992)

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[12] Path-dependency refers to technological and scientific dimensions, which should not be confused with the linearity of the neo-classical model of the innovation process (which refers to the automatic connection between expansion of the knowledge-base and technological development in the economy).

- new regional economics (Storper and Scott, 1992, and Storper, 1997)

- economics of learning and knowledge (Polanyi, 1988, Nonaka and Takeuchi, 1995, and Foray and Lundvall, 1996)

- economics of innovation (Freeman, 1982, and Freeman, 1994)

There have been important developments in each of these fields and a lot of interaction between them in the last ten years or so. The economics of innovation, with people like Christopher Freeman, Giovanni Dosi, Luc Soete, Paul David and Richard Nelson in key positions, has played a major role in connecting the different strands of thought (e.g. Dosi *et al*, 1988 – this piece of collaboration represented a break-through for the new ideas). Each field has contributed in its own way to the formation of the new theoretical paradigm.

Evolutionary economics has been helpful in emphasising the importance of diversity as a source of innovation and in modelling the innovation process as both cumulative and stochastic. It also helps to understand processes that include reproduction and transformation as well as selection. In relation to innovation policy it gives the policy-maker a less ambitious role than the optimising one implicit in neo-classical analysis (Metcalfe and Georghiou, 1997).

Institutional economics places itself at the border between theory and history, and offers a conceptual framework well-suited to encompassing the regularities in behaviour that characterise an economy where change and uncertainty is the rule rather than the exception. Norms and routines, shared perceptions and modes of interaction are often implicit, and are important since they are regularities without which little learning and innovation could take place. In relation to innovation policy this approach points to the opportunities and limitations of institutional learning, e.g. across national systems of innovation (Johnson, 1997).

Regional economics has always been more open to interdisciplinary influences than most other sub-disciplines in economics. The new contributions from Scott, Storper and a number of French economists include elements from the other subdisciplines mentioned and combine them with broader social theory in a creative way. They analyse how the different (inter-personal, intellectual, industrial and market) worlds are constructed and built around conventions and common interpretations. In relation to innovation policy this approach points to the need to build and renew local knowledge-intensive networks in order to create strongholds in global markets (Storper, 1996).

The economics of innovation has developed into a field of research which uses different theoretical tools often combined with historical analysis, and was central to the theoretical transformation discussed here. The enormous amount of empirical data gathered at different levels of aggregation has played a key role in stimulating new theoretical contributions and most of the 'stylised facts' referred to above emanate from such research. Major contributions to innovation policy have been the analytical work on national systems of innovation (Freeman, 1987, Freeman, 1995a, Lundvall, 1992, and Nelson, 1993).

The economics of knowledge and learning has been around in an embryonic form for a long time but it is only recently that it has been given an explicit emphasis (Dosi, 1996). It has been helpful in getting a better understanding of the organisational and spatial dimension of innovation. Much remains to be done in testing some of the basic concepts, such as tacit versus codified knowledge, and in connecting with other disciplines with more experience in working on these issues. One of its major contributions to innovation policy is to direct the attention of policy-makers to forms of knowledge creation that are not easily covered by traditional statistical measures (Lundvall and Johnson, 1992).

These sub-disciplines cannot be used in isolation to analyse the learning economy. They need to be connected to history, and some of the most interesting recent contributions in the field represent new combinations of theory and history (Nelson, 1994, and Freeman, 1995b). Such analysis is useful in highlighting the need for policy intervention in relation to potential mismatches between new technological opportunities and the organisation of the economy (Lipsey and Carlaw, 1996).

The new policy rationale

The evolutionary and systemic approach to the innovation process provides a new understanding of the role of policy action, and its rationale. This will be reflected in the next major part of this report where different aspects of innovation policy will be considered. Here we shall mention some of the TSER contributions that transgress the market failure perspective. Keith Smith and Franco Malerba have, respectively, developed a typology of 'failures' as a basis for policy action rationale. This does not, *a priori*, invalidate the Arrow-inspired 'market failures' and the risks for under investment, but both typologies go beyond the interpretation that failures are exclusively related to the properties of scientific knowledge. Failures are also related to other activities, processes or organisations that affect directly the technological performance of a given system.

Smith's four types of 'failures'

Failures in infrastructure provision and investment. When there is problematic under-investment in the two types of infrastructure with which firms interact, namely, physical infrastructure (like communications and transport), and science-technology infrastructure (like universities, regulatory agencies, publicly supported laboratories).

Public action should be directed towards setting up incentives for and controls on private provision, subsidies for private provision or direct public provision.

Transition failures. When firms are highly competent within their own technological area but not in other related areas. Public action generally aims to solve this problem implicitly, but public action should be more explicit and devise special measures for this type of failure.

Lock-in failures. When firms are not able to switch away from their existing technologies and get 'locked-in' to a particular technological paradigm or trajectory.

The rationale for public action is to generate incentives, develop technological alternatives and nurture emerging technological systems in order to make it easier for firms to move away from lock-ins.

Institutional failures. When the institutional and regulatory context is having an unexpected and negative impact on innovation in the system.

Public action here should concentrate on monitoring and assessing regulatory performance.

Malerba's evolutionary traps, trade-offs and failures.

Learning failures: Firms may not be able to learn rapidly and effectively. Public intervention has many different ways of tackling this kind of problem: human capital programmes, support for industrial R&D, public procurement, and dissemination policies.

Exploitation - exploration trade-off: Some industries may work on exploration, but not exploitation. Other industries may do the opposite, in both cases with negative effects. Public policy should try to ensure that the industrial system achieves a balance between the two. The author suggests three policy options:

- keeping technological rivalry open by supporting alternatives (i.e. by using public procurement and supporting universities)
- introducing diversity in the industry by supporting the entry and survival of new firms (SMEs)
- supporting variety through a common infrastructure (standardization and norms) and better dissemination of codified information.

Variety-selection trade-off: Industries may generate a lot of variety but have weak selection processes, or may have tough selection processes and little variety. Policy suggestion: antitrust and competition policies should be used in close relation to industrial and technology policy. This will affect the selection process allowing market competition to take place.

Appropriability traps: Too stringent appropriability may greatly limit the spread of advanced technological knowledge and eventually block the development of differentiated technological capabilities within an industry. The patent system is important for appropriability but not the only one, as secrecy, lead times, and complementary assets are also important. These latter fall outside the scope of public action.

Complementarities failures: The appropriate complementarities (required for sustained innovation) may not be present or the firm may not be connected to an innovation system. Public action should help by providing connections to trigger virtuous cycles. Examples could be supporting the formation of R&D networks, industry-university interfaces, and setting up bridging institutions.

The identification of theses new types of failures is intrinsically related to the rationale for public action.[13] This means that the typology of failures contains in itself a typology for public intervention. This second implied typology is based on the goals pursued rather than on the mechanisms or procedures used. (see the two boxes above).

These two overlapping typologies give a clear picture of the policy concerns raised by the evolutionary perspective. In order to move along these lines, they can be reformulated here into three general trade-offs:

- *The exploitation-exploration dilemma.* Lock-in failure, exploration failure and tough selection regimes all indicate that the design of the innovation system tends to make firms pursue narrow strategies and that radically new innovations and directions of change are not opened up. On the other hand, narrow trajectories may sometimes be the most efficient for moving rapidly ahead in terms of incremental innovation, dissemination and efficient use of innovations. We could perhaps follow Malerba and put these considerations together under the heading *'exploitation-exploration dilemma'*.[14]

- *The integration-flexibility dilemma.* Transition, complementarity and learning failures mean that the innovative organisation (firm, research institution, etc.) should be organised in such a way that it becomes an integrated learning organisation and cannot normally stand alone because it has too narrow a knowledge-base. Therefore it needs to be connected to other firms or knowledge centres. Such connections may be a key to innovation along a given trajectory but may also be a major factor in creating 'lock-in'. We could gather these aspects under the heading *'the integration-flexibility dilemma'*.

- *The diversity-harmonising dilemma.* The strong selectivity context of the globalising learning economy is a real incentive for harmonising and standardising technologies and institutions in an

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[13] Arundel and Soete (1993) set an important precedent for this new rationale of policy making, and deal specifically with the EU context.

[14] This dilemma played an important role in the Maastrich manifesto on innovation policy (Arundel and Soete, eds., 1993). Many of the ideas in this report overlap with those in the Maastricht document. In some areas related to the importance of competition and selection in the learning economy we go further than our predecessor, while in other areas we continue the debates already begun in this document.

attempt to benefit from economies of scale (for example, creating early standards, and homogeneous intellectual property rights, on a European and world scale). In fact, there are still important 'standardisation failures' in the EU. However, the institutional and technological learning capacity of the systems depends on the diversity of the knowledge-base and institutional structures. Diversity of factor endowments, of products and processes, of institutional and collective behaviour, and of learning abilities are four essential dimensions that make diversity a crucial source for learning. Therefore policies at all levels of government in the EU have to take into account the benefits of diversity while pursuing standardisation in some crucial areas where technologies have begun to be stabilised.

Infrastructure, legal instruments for appropriation, or more generally institutions and regulations, may be treated at a different level of analysis. They should be designed in such a way that they create an acceptable balance in the trade-offs referred to above. But they are not the only options for policy. Programmes designed to stimulate organisational and institutional learning inside and between firms and assist them in developing organisational innovation are becoming more and more important. Macro-economic regimes play a major role in determining the general direction of innovation. Financial markets and governance modes affect the short-termism of innovative activities.

It is obvious that the three dilemmas reflect a theoretical universe that is quite different from the neo-classical one. In the neo-classical universe, representative firms will do what is best for them, especially if left to themselves by governments, and there is little room for alternative strategies when it comes to developing new technology or designing the organisation and network position. A major difference is that in evolutionary economics, agents differ in crucial respects. Not only do they do different things on the basis of different capabilities, but their general economic competence is also different. Since capabilities and competences can be acquired through learning there is room for governments to support these learning processes.

It is a major task for socio-economic research to analyse which factors and institutional set-ups are most important in striking a balance between exploration and exploitation and between integration and flexibility. One specific important issue is how European policies should strike a balance between exploiting diversity and pursuing standardisation strategies at the Community level.

New directions for innovation policy over the last two decades

Picking winners or creating general framework conditions?

One factor that has delayed the development of appropriate policies has been the ideological debate about the old plan-versus-market controversy. As indicated above, analysis focused on innovation will demonstrate that 'pure markets' are problematic when it comes to stimulating innovation. It will also show that modes of interaction between firms involving a mixture of competition and co-operation are more efficient than 'pure competition'. The invisible hand is not so invisible anymore and the issue is not whether governments should interfere in a near-perfect market economy. This is not an argument for massive and detailed government intervention, but rather for a pragmatic and realistic assessment of what governments could and should do.

A favourite theme in the eighties was that governments cannot 'pick winners' and that this implies a move away from selective policies and a stronger focus on framework conditions, i.e. conditions that are in principle common to all firms in a national economy. This argument is sound but perhaps goes too far. On the one hand there is always a risk that governments become captives of specific industrial interests and detailed interventions and specific subsidies may create a culture of 'clientelism' among firms. On the other hand the concept of 'general framework conditions' is misleading in the sense that any set of framework conditions will affect different types of firms differently (for instance knowledge base, financial requirements and infrastructure needs will differ according to firm size and sector).

An interesting compromise between moving towards general framework conditions and taking into account that the most important framework conditions differ from firm to firm has been developed in some of the smaller OECD countries. In the Netherlands there has been a growing focus on industrial clusters which encompass vertically organised sub-systems of firms, while Danish analysts and policy-makers have broken down the whole economy into nine 'resource areas' with a forum for each of these areas including policy-makers, analysts, trade unionists and industrialists. These forums conduct informal debates as to which changes in the existing framework conditions are most needed and there is a close connection between these debates and new law proposals.

The major problem with such a model has to do with the exploitation/exploration and integration/flexibility dilemmas. In general, industrial policies are normally more efficient in consolidating exploitation of existing opportunities than in opening up new avenues. This comes out clearly when comparing national systems of innovation and the role of governments in this context (Edquist and Lundvall, 1993). And the normal tendency is to reinforce patterns of connectivity and linkages which are already there. Bringing policy-makers into close dialogue with groups of industrialists who command a common position in the economy will normally reinforce these tendencies.

What may be needed is to supplement these institutional set-ups with new bodies debating policy issues which are neither economy-wide nor sector-specific - rather like when innovative firms establish task forces to develop new products and services. These bodies would bring together the front runners and individual industrialists rather than representatives of the mainstream and the laggards.

Finally, it might be useful to link policy considerations to the 'learning economy' in a more specific way. Learning is a process that is not promoted by detailed regulations and intervention. The ideal learning environment is characterised by a predictable institutional framework and by incentives that make it attractive to learn in interaction with others. In this sense, the learning economy concept also gives priority to the creation of framework conditions rather than to detailed intervention.

Recent trends at national level[15]

OECD and EU monitoring of the development of the technology and industrial policies of its member countries provides a unique view of the most recent developments. The latest editions of the different country reports show that countries are beginning to shape their policies taking into account factors characterising a learning economy. It is possible to recognise six different trends in the formulation of national innovation policies.

Firstly, the distinction between industrial and technology policy is becoming less and less pronounced. Innovation is tending to become the main cornerstone of all industrial policy strategy consequently producing policies that aim to influence all the factors which promote technological innovation. In this context, it is interesting to note that more and more OECD countries are now in the process of carrying out analyses of what the OECD describes as 'their national system of innovation'. It orients the attention of policy-makers to linkages and interactions within and between different sub-systems. For instance, it is now unthinkable to optimise university systems without taking into account connections and interactions with industry and other major users of research and higher education.

Secondly, greater attention is being paid to the wide-ranging internationalisation of technological development and implementation. The ability to incorporate technology developed outside a country's borders is perceived as a decisive factor of competition. Firms are increasingly involved in international co-operation involving the development and use of new technologies. It is recognised that firms of limited size have difficulties in following this trend. Therefore, it has become a new task for governments to support firms in their efforts to internationalise their activities. This includes technology forecasting and the establishment of international rules for the sharing and protection of intellectual property rights.

Thirdly, a clear policy trend, already mentioned, is to move away from sector-specific subsidies and equivalent industry-specific arrangements. Industrial policy is gradually focusing on aggregated development blocks (also called 'resource areas' or 'clusters'), which consist of several mutually related sectors (Carlsson and Henriksson, 1991). It is also becoming increasingly common to look at how service activities are linked to different parts of manufacturing. There is a general tendency to recognise that services are becoming more important in relation to innovation and learning too and that the borderlines between services and manufacturing are gradually becoming less clear (OECD, 1996b).

Fourthly, there is growing recognition that new technology alone can not solve the problem of industrial and economic performance. Learning and knowledge are tied to people, and if the people cannot keep pace, there is little point in having access to advanced machinery or advanced computer programs. Not least experience with the application of information technology has shown that

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[15] This section is based mainly on the contribution by Bengt Åke Lundvall (1996): "Technology Policy in the Learning Economy" (unpublished paper).

without employee training and without organisational change, the use of technology can lead to dramatic reductions in efficiency. The need to stimulate investment in human resources and organisational change at the firm level has become more widely recognised by policy-makers (OECD, 1996a).

Fifthly, along with the gradual realisation of the systemic nature of innovation process, the emphasis on development of technology policy has shifted from the supply side towards the demand side. Given that the innovation and learning processes are interactive and involve both technological knowledge and knowledge of user needs, it is natural that the one-sided focus of technology policy on the producer side is gradually being abandoned in favour of a more balanced approach. In fact, those technology policies which seem to provide the most visible and positive results are those which place most emphasis on the user in development projects. In practice, this entails supporting measures to improve user competence, promoting co-operation projects which comprise both producers and users, or providing direct support to users who in turn - via co-operative purchasing mechanisms - stimulate producers to develop new and better products.

Finally, there has been a growing understanding of the importance of innovation policy for the performance of the economy as a whole, and of the need to coordinate innovation policy with macro-economic policy. The OECD study on technology, productivity, employment and economic growth initiated by the G7 countries marked a new step in this direction by showing that flexible labour markets and non-inflationary general economic policies are not sufficient to create attractive jobs and social cohesion. This was also a major theme in the EU White Paper on employment and growth.

These new tendencies are transforming the nature of government intervention. They indicate a shift in the perceptions and focus of policy-makers towards a wider understanding of the complexities and dynamics of innovation, and of the crucial role of learning in the economy.

However, developments in these respects are partial and very uneven. Often small countries tend to take the lead in introducing the new ideas. The Netherlands is most advanced in its cluster policies, Denmark in its focus on organisational change, Sweden in procurement policies to encourage users of innovation and Finland in using the innovation system perspective. In many countries and also in some parts of EU policy, there is still a tendency to take the linear model of innovation as the starting point and to neglect the new systemic perspective.

A general problem is that there is still little awareness of the fundamental dilemmas and trade-offs referred to above. Government policies still tend to promote movement along well-known trajectories and the reinforcement of already established networks. Actually it seems that policy action normally tends to reinforce what is already comparatively strong rather than to strengthen the weak parts of the innovation system. To indicate ways government can contribute to the opening up of new trajectories and the establishment of new patterns of co-operation and interactive learning is one of the main tasks of this report.

Concluding remarks

It is now possible to sketch the outlines of a new policy paradigm that takes into account both the characteristics of the learning economy and new theoretical developments. This new paradigm is oriented towards shaping an efficient innovation system that can adapt to rapid change.

The new policy paradigm focuses on creating adaptable innovation systems. This includes three interrelated issues: firstly, stimulating learning institutions and economic actors; secondly, developing integrative and coordinated policy visions and instruments for enhancing innovation; and thirdly, creating the conditions for a policy-making process which is also learning and adapting constantly to the new demands and conditions of the economy.

In order to transform these results into effective policies there will need to be stronger connection between policy learning based on practical experience and systematic evaluations of policy programmes. This is the subject of the next chapter on policy learning.

Chapter 4: Policy learning

Introduction

In the last chapter we examined the theoretical background of new policy trends and the need to design policy actions in new ways. From the theoretical understanding of the challenges and risks of the globalised learning economy a new policy rationale emerged, with a broader view about failures and the role of public action. However, two further points deserve attention. Firstly, the idea that policy should focus on institutional learning; and secondly, that policy-making itself should be a learning process.

Interactive learning is essentially an institutionally-embedded process (Dalum, Johnson and Lundvall, 1992, p 311). This statement rests on two interrelated assumptions. Firstly, the fact that economic performance might relate more to the existence of institutional barriers to change than to the lack of technical knowledge as such; and secondly, that institutional learning is central to the growth patterns of each economic system. We now go a step further in this discussion by relating the exploitation of the knowledge base to the institutional set-up. Institutional learning, or the capacity to adapt the institutional set-up to new circumstances and environments, is a key factor for technological development. As in the case of knowledge, it is possible for innovation systems to borrow institutional set-ups in the search for better performance. The following box distinguishes between institutional borrowing and learning.

> **Institutional borrowing** means copying economic institutions from a 'successfully perceived' country to another, with the purpose of improving the conditions for technological development in the second. **Institutional learning**, on the other hand, is a dynamic process through which economic and socio-political institutions evolve gradually, through a specific set of causes, and develop specific and well-defined strategies for innovation in a continuous virtuous circle. Causes are internal and external, but the process assumes specific outcomes through internal institutional dynamics.

Institutional borrowing has some clear limits, as foreign institutions are never fully transferable into a different systemic context from the one in which they where created. Therefore, borrowing implies to a greater or lesser extent a process of institutional learning and adaptation to the new system. This is inherent in the 'national system of innovation' concept.

The second element mentioned earlier, namely policy-making as a learning process will be examined in this chapter. This can be seen as the 'soft side' of innovation policy, which should be carefully designed too, in order to enhance policy solutions and strategies which are more effective, adaptable and accountable. This is based on the perception that public policy forms part of the innovation system (be it European, national or regional) and in this sense can no longer be perceived as

static, but rather as a dynamic element (indeed, a central element) that affects the overall performance of the system.

The new theoretical perspectives presented in the last chapter also point to policy learning as a natural ingredient in the innovation system. While the neo-classical approach focuses on well defined ideal states (general equilibrium) and assumes rational agents, evolutionary economics is more modest in these respects. While neo-classical economics presents the policy-maker as 'an optimising technology policy planner' (Metcalfe and Georghiou, 1997, p.1), evolutionary models 'suggest how informed judgement can direct policy to areas in which the chances of useful intervention is high' (Lipsey and Carlaw, 1996, p. 1). It is obvious that there is much more room and need for learning in the context of the evolutionary perspective.

This chapter therefore centres on this second dimension of the policy implications of the learning economy, with special attention to the need to enhance the learning abilities of public institutions and actors. A number of questions therefore arise in relation to the ideal policy definition, which depends on the nature of policy-making. What is the nature of policy change and what are the conditions for policy learning? How can this be improved at European, national and regional levels?

Enhancing policy learning

The literature on policy analysis largely considers the nature and forms of policy change and continuity. Due to the limits of the current report, it is not the intention here to review this rich literature within the discipline of political science, but rather to refer succinctly to some of the most salient and recent works on this topic.

Studies of policy change have traditionally taken as a starting point the so-called policy cycle, based on the different ideal stages of the policy process, namely decision-making, implementation and evaluation. The learning approach criticises this assumption because it does not appear to provide a satisfactory account of what happens after the decision-making phase, and especially because change is perceived as somehow automatic after the political impact of the evaluation. The learning approach, on the other hand, provides a fluid perspective of a policy process in continuous transformation and evolution where no clear stages can be discerned (Teubal, 1997, p 1180). In this sense the learning approach has been considered an advance on the traditional policy cycle model by providing an integrative framework for viewing change in the process from a non-linear perspective (Parsons, 1995).

This relatively new approach suggests that the keys to understanding policy change and the implicit learning dimension of the policy process are transformations in the collective beliefs within the political system (Sabatier and Jenkins-Smith, 1993). This contrasts with previous models which identified different ideal types of change (Hogwood and Peters, 1983).

The learning approach includes a set of normative insights which tended to be absent in previous approaches. The key normative statement centres on the need to improve and speed up learning in

the policy-making process. In this sense, Metcalfe emphasises the need to design adaptable systems and create conditions for policy learning.

Designing adaptable systems

"In the political environment of public management learning processes are especially difficult to create and maintain. Individual learning is a psychological process. Organisational learning is a political process. A critical task of public management is to build institutional learning capacities at the macro level to manage the environment in which private management operates. But, conventional political processes often block learning because ideology overrides evidence or vested interests resist policy evaluation and change...public management reforms are better regarded as management by design rather than by direction. (Therefore, policy-makers) should be concerned with designing adaptable systems rather than producing blueprints for specific reform" (Metcalfe, 1993, p 107-8).

Creating an adaptable system means two things. Firstly, as we mentioned earlier, enhancing institutional and individual learning within the innovation system; and secondly, improving the conditions for the innovation policy learning process.

We will now focus on this second aspect, and identify three specific measures for encouraging policy learning, namely, making more extensive use of external and independent sources for policy (re)formulation, enhancing social and political participation, and improving the possibilities for learning from others.

Making more extensive use of external and independent sources for policy (re)formulation[16]

Policy evaluation mechanisms have traditionally been the chief source of policy (re)formulation in the national context. In science and technology policies, evaluation mechanisms started mainly as mechanisms for checking the quality and relevance of draft and final projects subsidised by the state. The procedure most commonly used for this purpose in the different European countries was peer review. The current forms and mechanisms of evaluation of S&T policies have evolved from these procedures for controlling researchers' activities, to include examination of RTD programme performance, and an overall critical analysis of the S&T policy.

Evaluation means 'examining' and 'making judgements'. The term S&T

[16] This section owes much to the contributions of Luis Sanz (1997) and Svend Otto Remoe (1996).

> policy evaluation includes activities and practices that look back at the performance of specific projects, programmes or overall policy strategy. S&T policy evaluation refers also to on-going control mechanisms, the monitoring practices, which follow programme and project performance and/or impact before they are completely finalised. Indeed, there are other practices, such as appraisal, which refer to the activities developed at the beginning of a programme or project (what is sometimes called ex-ante evaluation and often related to a selection process for funding). (Sanchez, 1997)

The boundaries between those activities are fuzzy and subject to interpretation, depending on the country. Similarly, the organisational arrangements to carry them out diverge in important ways between national contexts. This national diversity is linked to the different forms of control activities developed according to specific historical processes, and more generally, to the development of (national) public management styles. Moreover, the use and impact of evaluations are also local and specific to each national context. On-going analysis of these differences and similarities shows that there is still no systematic approach to evaluation in most EU countries.[17]

However, in most EU countries there are clear signs that these patterns are changing. Monitoring is now well established and overall evaluation practices are becoming more politically relevant for the redefinition of policy strategies. In many countries, this has happened as a result of domestic forces. In others, like Greece and Portugal, where S&T policies have been established in close relation to the European Structural Funds, evaluation procedures have become a requirement imposed mainly by external forces (European Community rules) with the purpose of controlling the good use of funding.

Given these general trends in Europe, there is clearly a need to go further down this road towards more systematic evaluation procedures and more extensive use of evaluation results in the redefinition of policy. In other words, it is still necessary in Europe to maximise the potential feedback benefits from systematic S&T policy evaluation. This is supposed to stimulate learning within each innovation system, and between systems, and thus to increase the adaptability of policy strategies to the new globalising learning economy.

Some authors have gone further along these lines by stressing the need to enhance the role of international evaluation (Remoe, 1997), which is taken to include four different types of operation: evaluations conducted in/for international organisations; the development of international evaluation teams to operate in national contexts; international benchmarking and comparative studies of national contexts; international user groups and knowledge transfer units of national policy-makers.

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[17] See "Advanced Science and Technology Policy Planning - Towards the Integration of Technology Foresight, Technology Assessment and S&T Policy Evaluation" in a research project (ASTPP) under the TSER programme.

Technology assessment and forecasting are two other relevant sources for policy reformulation and key elements in the policy learning process.

Besides evaluation mechanisms, which are generally of an internal nature, there is a need to make more extensive use of external and independent technology assessment and forecasting resources. Independent technology assessment can decisively contribute to the definition and improvement of technology and innovation policy strategies from a medium- or long-term perspective. Technology assessment works also as a bridging institution at the highest level, in the interface between technical and economic expertise and society. In this sense, technology assessment has the dual task of promoting and controlling activities under the chosen technology options.

There have recently been attempts to re-emphasise the importance of technology assessment in the formulation of S&T policy alternatives. The notion of "constructive technology assessment" follows new efforts to introduce dynamic elements into the previous more static approach. The traditional assessment analysis of the unequal distribution of negative and positive externalities in society, needs to be complemented with a more dynamic approach "focusing on the broad societal integration of technology in society and the adaptation of technology to society's needs" (Soete, 1995, p. 45). This new approach is still based in the notion of externalities, but from a dynamic and systemic point of view.

Enhancing the social and political participation in the definition of technological alternatives

Most national decision-making procedures in the field of S&T policy include a form of social and political participation. One of the most common forms is representative committees, on which different sectors of society are represented (such as trade unions, environmental groups, scientists, political parties, business associations, etc.), and which are independent from government structures. They usually have only advisory and consultative responsibilities, producing reports and statements with a greater or lesser impact on the decision-making process. In most European countries, such committees officially play a prominent role in the definition of technological strategies. However, in most cases, their real power is much smaller than what officially recognised. In some European states, these committees are organised at sector level, either by scientific area or by industrial sector. In others, there is only one committee, with aggregate functions and interests. Whether or not they are centralised or decentralised does not *a priori* determine their impact on the social debates initiated by them. A wide range of structural and political elements determine their impact and their influence on decisions and policy outcomes.

A more classical form of socio-political participation is of course the parliament, and its role in the policy formulation stage. Most national parliaments have parliamentary committees specialised in technology matters. These obviously include members of parliament representing the formal opinions of the different political parties. They are an interesting forum for preliminary debates and decisions, which will eventually be voted in plenary session, recording the opinion of parliament on given technological strategies. In order to assist these committees, most parliaments have set up their own technology assessment units of scientists and specialists as

technical sources for evaluating government proposals. However, there are in the EU still national parliaments that have no such units, leaving them entirely dependent on the technical expertise provided by the executive arm of government.

It is important to note here that the Member States and the EU already have formal institutions and organisations which directly or indirectly encourage social participation in decisions on technological alternatives. However, it is equally relevant to point out that many local and regional authorities have no such formal participatory mechanisms. Debates are therefore held almost exclusively between political parties and groups of experts.

Opening up more real social participation at all levels of policy-making (European, national and sub-national) could be a way of stimulating the emergence of a collective vision on technological development alternatives, a positive input into long- and medium-term policy strategies. Another positive aspect of a higher level of, and more meaningful, social participation is wider social acceptance of technological development. Interesting experiences of large consultative meetings (the so-called 'consensus conferences in Denmark' where experts and all kinds of social groups debate problems, strategies and their alternatives) show that there is a tendency for these activities to foster, on the one hand, better informed and more critical debate but also, on the other hand, wider social acceptance of new technologies.

However, there might also be initial problems in combining the interests of very different socio-economic sectors, and in mobilising different social groups to engage them in the debate. Mass media could play a useful role here by echoing and 'translating' the different experts' views on technological alternatives. Similarly, fostering such debates in the educational system could make citizens interested in technological matters. These are both ways of solving, at least in part and in the medium term, the problem of effective social mobilisation and participation in Europe at all different levels of government. It is generally true that those most sceptical to technology are those who run the biggest risks of losing their jobs and those who have least influence on the decisions taken. Reestablishing full employment and making economic life more democratic in Europe are, in this sense, perhaps the most important ways of creating a more positive atmosphere for innovation.

Learning from others

Learning from others relates here partly to the discussion about institutional learning and borrowing. Policy-makers today face the increasingly complex task of providing effective incentives to foster innovation processes. This requires a substantial pool of new ideas, strategies, and experiences. Social participation and independent sources for policy re-formulation help with this. However, policy makers also need to look carefully at initiatives taken in other countries as a source of further inspiration.

We considered earlier the limits of institutional borrowing, and the conditions for institutional learning (related to the diversity of each system's knowledge base and organisational performance), concluding that it is possible to 'learn from others' on the basis of diversity.

Dodgson and Bessant (1996) provide different examples of policies that have been transferred across national borders.

- The concept of science parks has been transferred from the USA to Europe and Asia.

- The policy of collaborative R&D programmes, stimulated by the Fifth Generation Computer Project in Japan, has been replicated by most industrialised nations.

- The promotion of venture capital in the USA has been successfully copied by Europe and is being encouraged in Japan (op.cit., p. 204).

The question is how to exploit effectively European institutional and systemic diversity in order to enhance mutual policy learning. As mentioned earlier, some authors insist on the creation of international evaluation schemes and operations to help achieve this exchange of ideas and experiences from a comparative starting point. However, this is not the only way. A more effective solution might be to create and support flexible international forums for the pooling of ideas and experiences.

The European dimension of policy learning

In a special contribution to this report Dominique Foray raised an interesting question: What is the true domain of 'a European policy' (see also Foray, 1997)? He argues that the European domain should be unique and not overlap with policies at regional and national levels, and concludes that there are two dimensions for European policy: harmonising and making technologies more uniform, and exploiting and reproducing technological variety. His point is that the unique characteristic of Europe is its multi-national character and variety between nations, and that exploiting this variety is possible only at European level.

This view can also be applied to policy learning. On the one hand policy learning across national borders may result in copying and in making institutions and policies more similar. On the other hand the variety leaves ample room for experimenting at local and national level, and for sharing and analysing the experiences from such experimentation.

One area where some standardisation might be useful is in relation to the university system. In another contribution made especially for this project Jan Fagerberg proposed the following text:

> *«The European knowledge base is characterized by a high degree of diversity. In an innovation policy context, this may be a strength, since diversity breeds innovation. But this is only so as long as the knowledge base remains integrated, characterized by a high degree of interaction between the constituting part. As emphasised by Schumpeter, innovation consists of new combinations of existing elements. A disintegrated knowledge base may hamper innovation (i.e. new combinations) in spite of considerable diversity.*
>
> *The university system, and education more broadly, plays an important role in unifying the knowledge base. It is therefore imperative that the university system acquires a European dimension. Although universities will remain a national responsibility, it will be an important task for the European institutions to support the creation of a European dimension within the university system. This should not be limited to exchange of*

students and teachers, but should also include more ambitious attempts to foster European co-operation in this field, such as the creation of European curricula, degrees, etc. » (Fagerberg).

At the same time the university sector, as will be argued in the next chapter, is one where there is a need to experiment with new forms of organisation that respond better to the new context of the learning economy and to new needs for skill formation and inter-disciplinary work. In this, as in most other areas, the European project might provide unique opportunities for policy learning that create more diversity by supporting experimentation while at the same time making systems more uniform in dimensions that make European-wide academic training possible.

In general EU Member States have great opportunities for engaging in and exploiting such learning processes. The EU institutions, the implementation of the R&D Framework Programme, and technological measures under the Community regional policy support frameworks provide formal and informal mechanisms for pooling and exchanging experiences. Similarly, the studies undertaken by the Commission on S&T indicators in the EU, and on national systems of innovation are valuable analytical tools for this type of mutual learning process.

However, regions and local governments do not have similar opportunities as the national authorities. Learning from others generally takes place through the (sometimes) intense exchange of experiences within specific cases of cross-border regional co-operation agreements (like 'Atlantic Arc', or 'The Four Motors for Europe'). The recently created 'Committee of the Regions' - a new EU institution - is a more formal example of an interesting and flexible institutional basis for pooling ideas.

Further international initiatives of this kind could be useful, enhancing cross-border interactions and mutual knowledge. This will be especially significant for the sub-national levels, which are apparently less active in this process.

Change, continuity and effectiveness in S&T policies

In the field of innovation policy, policy learning relates to the way in which policies and strategies change. Policies tend to evolve, but seldom through radical change based on the introduction of a new theoretical paradigm. Gradual adjustments based on the intuition, common sense and political strategies of policy-makers, and clear continuity of strategies co-exist in time.

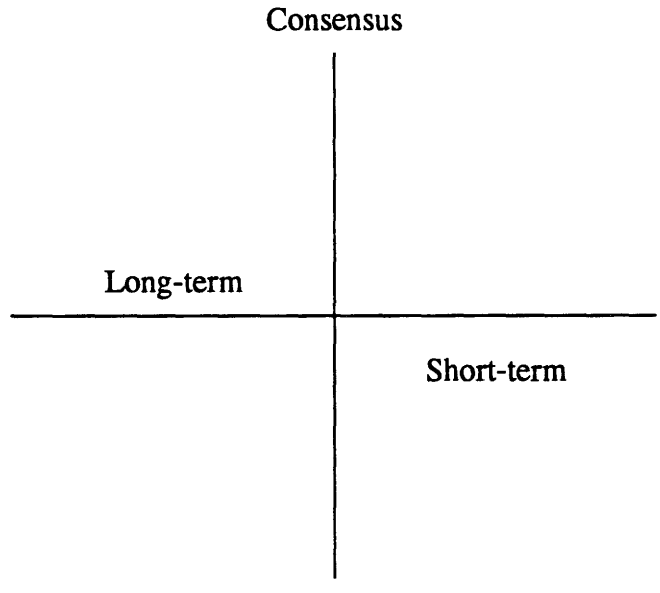
Policy learning in innovation policy

"Innovation policy has been described here as a process of policy learning. It is clear, however, that it is a case of both indirect and direct learning. Policy learning is partly a process of institutional learning, i.e. a process of gradual reshaping of the institutional set-up. New types of instruments and new practices for decision making and policy evaluation are developed. In fact the whole way of thinking about innovation policy has started to change lately as a result of a shift from a linear to a more interactive and systemic way of thinking about innovation processes. But often the new practices of innovation policy have evolved rather than being created by deliberate design. Further, innovation policy is not systematically guided by the state of the art innovation theory. It is more guided by intuition and economic common sense and the linear model of innovation still seems to carry some weight among policy makers, who also seem to concentrate much more on creation than on diffusion and utilisation of new knowledge". (Johnson, 1996, p.18).

Countries and regions have their own politico-administrative and socio-economic traditions, which define particular combinations and styles of policy change and continuity. Politico-administrative traditions tend to develop policies which reinforce existing industrial and productive processes. In this sense, continuity in policy decisions and objectives might result in policy lock-ins where alternatives and change are problematic and slow. However, change is always difficult, especially if it entails radically new elements in a decision. The difficulties in breaking away from policy lock-ins to define new policy orientations (for establishing new industrial and economic trajectories) are diverse. We can identify three here, namely, the lack of a constituency (interest groups and relative socio-economic mobilisation) openly interested in the new orientation; the lack of experienced policy-makers in the area to effectively carry out the new measures; and the fact that policy mistakes are both more probable and politically more visible when there is a new policy.

The identification of possible policy lock-ins in a system, due to a perverse form of policy continuity, is an important question. The evolutionary and learning perspective assumes that the success of the innovation system depends on its capacity to adapt constantly through a process of learning by knowledge accumulation and forgetting. This perspective thus has an initial bias towards the positive effects of policy change. However, in practical terms, all systems and policy styles have specific combinations of change and continuity. In other words, both coexist in time. The point is then not only to examine the ability of the system to introduce change, but also to consider the characteristics of the socio-political context in which the decision was taken.

We have identified two variables that form the socio-political context: on the one hand, whether there is a tendency towards short- or long-term political strategies, and on the other, whether the political tradition is of consensus or conflict in policy-making. These two variables give us a basic typology. This typology is not normative in its intentions, but serves to analyse concrete empirical cases. It should therefore be possible to position specific examples of countries or policy instruments in the four boxes below.



We are not assuming that one of the above types is 'per se' any better than the others. A priori consensus-based decisions will be more accepted and less problematic than those based on conflict. But the question is, how wide in fact is the consensus in social terms, and how effective and adequate is the decision (consensus might be based on preserving the status quo rather than on opening up new perspectives in the policy decision). Decisions taken in conflictual contexts may seem a priori to be inefficient, but this might not be the case if different interests and visions have competed in an open democratic contest for alternative solutions, and have chosen an effective one.

The same is true of the distinction between long-term or short-term decisions. How efficient they are will depend on the type of decision, and the way in which it affects the system, rather than the time perspective. An accumulation of effective and efficient short-term strategies with precise goals might work more positively than a long-term strategy that is vague and ill-implemented. Still it might be true that short-termism in policy-making is a major problem when it comes to environmental issues and that it might be necessary to build new forms of organisation with more long-term emphasis to make sure that economic growth remains socially and ecologically sustainable. This should not be confused with current attempts to move responsibility for economic policy away from popular influence and put it in the hands of central banks. These attempts may actually end up reinforcing short-termism in the system as a whole.

If this typology does not entail any normative assumption, how can it be possible to evaluate the effectiveness of S&T policy-making in a given system? The answer might be to focus more on the appropriate balance between change and continuity and the policy dilemmas spelled out in chapter 3, where the conditions for policy are such that the 'fine-tuning' of decisions is possible and relatively unproblematic.

Johnson contributes to this question of effectiveness by identifying different levels and dimensions of policy learning in innovation policy:

1. Forming visions about the learning economy as an environment for innovation activities. This includes negotiations between private and government policy-makers leading to consensus in some areas, and to compromises or recognition of conflicting interests in other areas;

2. Developing new concepts, data sets and theories of innovation which increasingly build on an innovation systems approach, explicitly or implicitly;

3. Building up new institutions and organisations to support innovation;

4. Gradually trying, testing and establishing new practices and routines in the conduct of innovation policy" (Johnson, 1997, p. 16).

Here we would refer back to Chapter 2, and add to that list the need to get a proper understanding of innovation as an integral part of wider strategies. There is a need to calibrate innovation policy in relation to: policies that increase the pressure for change; human resource development policies; and social policies aimed at compensating the losers in the process of creative destruction. Policy learning must be open to wider signals and feed-backs than those coming from the immediate sectoral interest groups.

The need for further socio-economic studies

Despite the general remarks we have made and implications for enhancing policy learning, we still know little about the characteristics of policy change and development in this area at national and EU levels. The dimensions of policy change are transformed according to institutions and institutional dynamics, administrative culture, political ideology, interest representation mechanisms and the formation of ideas, and there needs to be further analysis in the specific area of innovation policy and its connection with wider policy strategies.

Different conceptual frameworks and policy analysis notions have been used in empirical studies of these policies. However, a more systematic approach is still badly needed, both in terms of conceptual and theoretical frameworks, and in terms of the object of study. Firstly, a specific conceptual framework has to be established which looks specifically at the joint evolution of policy actions, and industrial and innovative dynamics. Secondly, we can then make a comparative analysis of different EU national contexts, which could be useful in providing a range of evidence about how and why (or not) policy learning takes place effectively (meaning, jointly with industrial dynamics). This opens up an ambitious research agenda, the results of which could provide useful information for policy-makers about the institutional bottlenecks effective policy learning, and about interesting alternatives provided by other national or regional contexts.

Chapter 2 and Chapter 3 have considered the crucial question of a new policy paradigm and stressed the need to enhance vertical and horizontal coordination of public policies as an essential issue in the (re)design of an effective strategy for technological innovation in Europe. The following chapters, Chapters 5-10, all in Part II of this report, will look in greater depth at different policy areas which together form the 'core' of innovation policy at all three levels of government, reaching sector-specific conclusions about the policy implications of the globalising learning economy in Europe.

PART II: The New Theoretical Context and Its Policy Implications

Chapter 5: Science policy in the new context

Introduction

What resources should governments allocate to basic science? According to what criteria should these resources be allocated between different scientific fields? How should scientific activities be organised - by specialised and autonomous public organisations or within private firms? Such questions have become increasingly important as the volume of public expenditure to science has grown and the pressure on public expenditure has increased. In this chapter we shall address only some aspects of these questions. Evaluating science as regards its importance to innovation gives a limited perspective on the role science plays in modern society.

First, science has become an integrated part of modern culture, and the insight it gives into the laws of nature should be seen as a constituent element of a developed and civilised society. It also represents a critical reflection on society and the way we interact with nature, which may be said to be part of a modern democracy. In this sense science may be regarded as a kind of basic commodity in any highly developed society. So, even if scientific endeavour gave no economic benefits at all it would still be worth continuing to fund a fair amount for cultural and political reasons.

Second, there might be political priorities which are more important than economic ones when it comes to allocating resources between different scientific areas. The classical example is expenditure on scientific activities connected with military technology, but there are also more or less absolute targets for science in other areas such as conquering space, eliminating certain health problems such as Aids and cancer, or finding ways to avoid long-term threats to sustainable development such as global warming and pollution. Such programmes will normally have a major effect on innovation and, as we shall see in the chapter on public procurement, they may be some of the most important vehicles promoting innovation, but their primary aim is to contribute to specific non-economic goals.

What we shall focus on in this chapter is scientific activities only insofar as they are linked to technical innovation and economic performance. To a certain degree this means focusing on specific organisations such as universities and public research laboratories and on their interaction with technological institutes and private firms.

Evident in the most recent literature, including TSER-related projects, are differences in interpretations of what is currently going on in these respects. On the one hand it has been argued that science should not be expected to make its contribution to economic growth through specific inventions. Its role is rather to build the capacity to solve complex problems, for instance by training students at universities. According to this view, attempts to measure its economic impact primarily via the specific innovations it has inspired are missing the point. The allocation of resources should be based on peer reviews rather than on cost-benefit analysis. A certain autonomy is important in order to create an environment where high-quality science promotes training for high-quality solutions to problems.

On the other hand, it has been argued that there has been a strengthening of the connection between technology and science whereby technological advances have become much more directly connected to scientific advance so that there is now a growing potential for exploiting scientific results in the form of innovations and economic profit. Also, it has been emphasised that linking universities much more directly to industry is both possible and useful, both for the universities and for the competitiveness of innovation systems.

Instead of trying to establish a middle-of-the-road compromise on these issues, we shall argue that they reflect different real trends and therefore that the apparent contradictions reflect contradictions to be found in reality. In general, it is true that the major contribution of science is that it builds skills rather than serves a direct source of innovation. But, at the same time, the connection between science, innovation, and economic performance is becoming much closer in some sectors of the economy such as biotechnology and software development. To this we shall add some reflections on how the role of science is redefined by globalisation and by the acceleration of innovation. We shall end up by arguing that there are dilemmas and trade-offs in these areas which have to be worked out through a political process and through the establishment of new forms of organisations which place themselves between and interconnect the world of academia and the world of technology and industry..[18]

Scientific activities take place in an artificially simplified environment

In order to reach conclusions it is important to specify some of the major differences between science and technology. We shall do so at two different levels. First we shall analyse how scientific activities differ in terms of form and content from activities in the field of innovation, and second we shall focus on differences in the rules of the game and institutional set-ups between the world of basic science and the world of technology and industry.

One traditional difference between the scientific activities carried out in research organisations and the innovation activities in firms is that the first is generally pursued in a controlled environment while (Pavitt, 1995) R&D in the business sector has to confront a radically different degree of complexity and on-going change. 'Under laboratory conditions' and 'everything else being equal' are terms indicating the limited validity of scientific experiments. In science-based firms, laboratory work may be a part of the innovation process but there will always be processes of scaling up and adaptation that involve elements of trial and error. Another difference is the kind of specialisation taking place in the two fields. In science, continuity seems to be a major element, and the enormous growth in scientific activities makes narrow specialisation necessary in order to reach high-quality performance. In the productive sector, the problems to be solved are complex and rapidly changing, which means combining different kinds of expertise and often an individual has to move from one field of specialisation to another.

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[18] This chapter has drawn extensively on two recent papers by Keith Pavitt (Pavitt, 1995, and Pavitt, 1996) and on a contribution by Dylan Jones-Evans produced especially for this report. The conclusions and recommendations remain the responsibility of the authors however.

Thus the differences in what science is doing and what business is doing in relation to the innovation process are reflected in the way activities are organised, the incentive systems used and their respective ways of producing knowledge. Together, all these differences have traditionally been perceived mainly as a sort of natural 'barrier' between the two worlds, restricting personal mobility between the two - which limits the efficiency of the interaction between those operating in the two different worlds. This is the view that science and industry will typically speak different languages and operate on the basis of different sets of value premises.

However, this characterisation gives a rather static view of the role of science in innovation systems - and specially in relation to industrial activities - which is partly inaccurate. "Science does not stand outside of society dispensing its gifts of knowledge and wisdom; neither is it an autonomous enclave that is now being crushed under the weight of narrowly commercial or political interests. On the contrary, science has always both shaped and been shaped by society in a process that is as complex as it is variegated; it is not static but dynamic" (Gibbons et al, 1994, p. 22). Whereas structural differences might still separate both worlds, there are two further points to consider. Firstly, there has been a change in the predominating mode of knowledge production. Secondly, in spite of the barriers, science has made important contributions to the innovation process and to technological development in the industrial world.

Following the attributes of the new mode of knowledge production identified by Gibbons et al (1994), science is progressively becoming transdisciplinary by transcending the traditional boundaries between disciplines, it is being produced in a context of application rather than one of problems set and solved by a specific community, it is increasingly heterogeneous, non-hierarchically organised and is becoming more socially accountable than before.[19] One specific example of the new mode of knowledge production is the role of scientists, who by adopting a strategic approach to their own careers are becoming 'entrepreneurs' and are crossing the boundaries between disciplines.

The next section will examine the barriers between science and industry, showing how the contribution of science could become particularly significant in a period of accelerating change in the business world. The major inputs to innovation are the very specialised skills learned in scientific activities, and the instruments developed and networks built around these skills. While most scientific discoveries might have a long way to go from the university laboratory to the market place, the limited direct effects do not reduce the relevance of the indirect impact.[20]

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[19] It is important to remark that the distinction between the old mode of knowledge production and the new one is a hermeneutic one. Reality is further more complex, and both modes coexist in time. This is to say that the real world of scientific production is being gradually transformed, and new practices take place alongside old ones.

[20] One of the considerations to be raised in this chapter is that acceleration of the rate of change in the private sector, which we refer to as 'the learning economy', creates new tensions in these respects. The differences in the rhythm of change between academia and business create new conflicts in the interaction between the two. Another consideration relates to possible globalisation

Barriers between research institutions and industry are functional and dysfunctional

In the last twenty years or so a number of innovation-oriented programmes which aim at reducing the barrier between research institutions (universities, research councils, laboratories) and industry have been designed and implemented. Therefore it is important to note that the barrier is functional and dysfunctional at the same time and that should the barrier disappear completely we might end up with a less efficient innovation system than the one we have. The barrier is functional in the sense that it gives science the possibility of building up, in the long term, highly specialised competencies which are in great demand among innovating firms. It is also functional in the sense that it allows a broadly oriented search for new insight which from time to time will result in scientific and technological breakthroughs. Discoveries through serendipity (cases where the most interesting findings come unintentionally and to the surprise of the scholars involved) are important for the overall innovation process and there will be more scope for such discoveries in organisations less strictly governed by economic incentives.

On the other hand, the very rapid rate of change in the market sphere, which is a feature of the learning economy, tends to make the dysfunctional aspects of the barriers more apparent. Such negative aspects may involve different phenomena.

- The very specialised and discipline-oriented training in universities may result in bad habits among students which have to be reprogrammed when employed in business in order to master interdisciplinary collaborations and to be willing to extend their specialisation into new fields.
- There are well established competencies at the universities which could be made more accessible to industry without compromising university autonomy if the appropriate organisational set-ups were established.
- The agenda of academic research may be conservative mainly because of a lack of information about what is going on in industry.
- In some very rapidly changing science-based areas such as electronics and software there may be a growing gap between the competencies needed in industry and what universities can deliver because industry tends to become the intellectual leader by investing the biggest amounts of resources in science and attracting the intellectual elite in the field.
- In certain new fields such as biotechnology and software the step from scientific discovery to the establishment of profitable production is short, so given the right organisational framework university research would be transformed into new knowledge-intensive start-up firms.

The question about the positive and negative effects of the barriers between scientific research institutions and the industrial world relates back to the integration/flexibility dilemma mentioned in Chapter 3. Individual firms and research centres need to be connected to other type of organisation in order to expand their own narrow knowledge base. However, this connectivity does not have positive implications per se. Connections to other organisations might end up as a sort of 'trap', in the form of a technology 'lock-in' for the individual firm or research institution.

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of the production and distribution of knowledge. Is it still rational for governments to invest in basic science in a world where science is becoming more and more internationally fluid?

One major task for science policy is to find ways to reduce barriers when they are dysfunctional without undermining the functional aspect of these barriers. Taking the first three elements from above as the starting point, the following policy remedies could be suggested:

- make university studies - or at least part of them - problem-oriented and promote co-operation between students and scientists working in different disciplines
- give stronger incentives for scientific staff to move between academia and industry
- create new forms of organisation which open up access to the knowledge-base of universities but which also shelter the academic community from too much profit-orientation.

The last two issues in the list of negative barriers point to policy options such as stimulating entrepreneurship among academic staff and giving more attractive salaries to academic staff in the most dynamic science and technology fields. Here, there are real dilemmas. As the material conditions of universities and their staff become increasingly dependent on exploiting intellectual property rights and as staff become increasingly focused on material incentives, some of the specific functions of the university (worldwide dissemination of results, quality control as more important than profit, etc.) may be jeopardised. There is a strong need for ingenuity in finding new institutional and organisational solutions which make it possible to combine the two considerations. Sometimes these will result in the creation of new organisations which can work both as links and as gate-keepers between the two worlds.

Does it pay for national governments to invest in basic science?

As discussed in Chapter 3, one classical reason for why governments need to invest in basic science is that it is impossible for private operators to appropriate the benefits from such investment, the uncertainty about outcome, and indivisibilities in the production of knowledge. The absence of effective appropriability instruments is a specific form of market failure which according to neo-classical analysis gives a legitimate reason for government intervention supporting basic science. However, investment in the development of technology may be left to private firms when technologies are specific and where intellectual property rights can be established.

This perspective is, as we stated in Chapter 3, too narrow since it tends to neglect important dimensions of the innovation process which have to do with the need for diversity and the risk of lock-in. Here we would emphasise that the distinction between knowledge which is public and knowledge which is private is blurred in real life and that the question of appropriability becomes correspondingly more intricate. [21]

Again, this is an area where there are different interpretations of what is going on in the economy. On the one hand, there is a tendency to emphasise the tendency towards codification of knowledge in the economy as a whole. Advances in information technology provide both instruments and stronger

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[21] We shall return to this in connection with the chapter on networking where it will be argued that one main rationale for the formation of networks is the collective production, sharing and appropriation of knowledge.

incentives to codify, and it creates world-wide communities and networks which can share knowledge. On the other hand, other scholars emphasise the limits for codification and the strategic importance of tacit knowledge which cannot be shared over great distances. They emphasise that *one of the main economic impacts of scientific production is its capacity to build crucial skills and competencies in the system which are tacit and local and which constitute a critical asset for appropriating more rapidly and efficiently the rapidly changing innovation process.*

There has been a change in the willingness of governments to support basic science. To a certain degree this change reflects an exaggerated view of the globalisation of knowledge production. Scientific knowledge may seem to be the most codified and global part of knowledge and therefore the question of appropriability is now raised at a new and higher level. Why should national (and regional) authorities use tax-payers money for something which can be obtained just by plugging into foreign university systems? There has been a change towards a model based on 'value for money'. This is what some authors have identified as 'a new social contract for basic research' emerging in different national contexts (Martin and Salter, 1996). The previous model, which operated since the war, was characterised by limited public concern about exactly what kind of benefits support for basic science would produce in the system. This scenario has now changed. At the beginning of the 1980s, public expenditure came under strain and demands for greater public accountability grew in the US and UK administrations. Today, in most OECD countries the amount and distribution of public resources to basic science is under discussion; evidence too that the linear model of the innovation process (financing science will unequivocally result in innovation) is no longer taken for granted.

On the basis of these social and political concerns, many econometric studies have tried to estimate the impact of research on productivity, almost all of them showing that there is a positive rate of return on funds supporting basic science. "The econometric literature on localisation effects and spill-overs suggests that advanced industrial countries need their own, well-developed basic research capabilities in order to sustain technological development" (Martin and Salter, 1996, p. 50). Similarly, economic studies of the relationship between basic science research and its economic impact show a positive correlation. The following box summarises the findings of these studies as regards the six most direct benefits from public support of basic research.

The idea that basic science increases the stock of information, which is a public good, has been traditionally argued as the primary rationale for public support of scientific activities. This cannot be denied, but basic science does not only produce information, in the form of codified knowledge. It also produces tacit knowledge, of paramount importance for the innovation capabilities of the system. The role of basic science in the development of human resources in the system is especially crucial. This takes three forms: firstly, through the creation of skilled graduates who move on from basic research, carrying with them both codified and tacit knowledge; secondly, because basic scientific research is essential in order to take part in national and international networks of scientists where knowledge is exchanged and generated through intensive interaction; and thirdly, basic science is itself oriented towards problem-solving, which provides optimal training for researchers moving on to other more applied scientific research and technological development.

Basic science builds and enhances the scientific capability of a system, and it is necessary in order to get meaningful access to and exploit advanced science and technology developed abroad. It is

possible, for example, for anyone to log in to the home-page of the leading groups of scientists and down-load their latest articles, but it is only meaningful if you have reached almost the same degree of excellence. It is certainly true that global interaction takes place in the field of basic science and that new IT development, like the Internet, increases the intensity of this interaction. But the main impact might be that the leading centres form elitist networks and move further ahead, which means that having a solid international reputation in science is a prerequisite for future economic success. We then have a new form of appropriability where networks rather than single individuals or organisations realise the potential benefits.

Different Types of Benefit from Basic Research

"The various forms of economic benefit from government-funded basic research can be classified into six broad categories:

1. Increasing the stock of useful information
2. New instrumentation and methodologies
3. Skilled graduates
4. Professional networks
5. Technological problem-solving
6. Creation of new firms.

These different forms of benefit are, however, interconnected and mutually supporting; for example, the training of skilled graduates not only promotes the development of professional networks but also facilitates the transfer of new information and methodologies into industry" (Martin and Salter, 1996, p. 16).

Other benefits are identified by the SPRU report. For example, the fact that basic science makes an exceptional contribution to the creation of new instrumentation and methodologies, which when transferred to firms can open up new technological opportunities. Also, as discussed earlier, despite the barriers between research institutions and firms, in some sectors basic science can produce important spin-off effects in the form of SME creation. Interesting evidence to this effect has been found in one of the TSER projects, showing that basic science is no longer the exclusive domain of public research institutions and giant firms, but that there are many SMEs which are increasingly undertaking such scientific activities (Keeble and Lawson, 1997).

Finally, basic science is an invaluable asset to the innovation system, providing openings for radical innovations. In the present era of intensified competition there is a tendency to make firms and other innovative organisations pursue relatively narrow innovative activities searching for short-term profit, 'market niches' and the benefits of narrow specialisation. However, while rational as an

individual strategy, this might turn out to be negative for the system as a whole, since too few resources may be used to open up new scientific frontiers and technological breakthroughs. Basic science could play a pivotal role in this context. The fact that it is not completely under the regime of the market but follows a different logic leaves room for exploration and unplanned invention. In the context of the accelerated innovation process, this ability of basic science might be regarded as a crucial element in avoiding technological lock-ins in the system.

On the importance of advanced demand

It is obvious that having a strong science base may give a competitive advantage to certain industries such as the chemical, electronics and biotechnology industries. Universities and other public research institutions can contribute by producing competent employees who can use their skills to pursue technical innovation. But other sectors use the inputs from basic science much less directly. In some sectors - for instance furniture and clothing - design skills are as important as the input from scientists. In mechanical engineering many different scientific disciplines and technological fields may be involved (new materials, electronics and scientific instruments) but the core competence is more practical than theoretical and access to skilled workers may be the key to competitiveness. This implies that the role of science and its connection to the demand side is very different in different parts of the economy.

This becomes even more obvious when we take the service sector into account. The debate about science and innovation has so far focused mainly on the needs of the manufacturing sector in relation to different aspects of technical engineering. As the service sector becomes more important in terms of volume and begins to play a more important role in serving the rest of the economy with information and knowledge there may have to be a change in priorities. Social science and humanities have more to say about human interaction and communication than sciences related to engineering. Within engineering, software development will become more important than material sciences.

In all these different areas it is important to realise that the quality of the science base will to some extent reflect the quality of the demand side. Having access to interaction with the most advanced users outside the academic world might be a key to long-term success. Advanced users will typically force the academic community to stretch the imagination, while taking into account and respecting the specificity of basic research. Therefore policy alternatives which enhance the capability of users of science may be an important part of an innovation-oriented science policy. In the next section we shall argue that when there are no advanced local users and when they cannot be expected to be upgraded as users, research institutions should be stimulated to find partners abroad.

This interpretation points to the need for an innovation policy involving a complex mix directed at the science system. On the one hand there is a need to promote excellence in order to gain access to the most prestigious and dynamic global networks. On the other hand there is an immanent tendency in the global academic system toward increasing disparities. The weakest players will be those with weak scientific capability in the most dynamic fields of science and technology. Therefore, science policies should combine excellence and egalitarianism in terms of human resource development.

Similarly, complete specialisation in specific scientific fields cannot be recommended, neither for regions nor for national scientific production systems. In order to absorb knowledge from abroad a certain minimum of scientific capability is necessary. Since most technologies represent an amalgamation of many different scientific disciplines, a very narrow knowledge base in the scientific research institutions will hamper technological developments.

When timing is crucial for economic success, it might be tempting for national governments to try to limit the access by foreigners to new scientific results, as in the US where there has been fierce debate on this issue. But such a strategy can easily lead to retaliation and result in a situation where co-operation has to involve local partners that are second rate because access to international networks has been restricted. The opposite strategy, whereby scientific research institutions are encouraged to establish international alliances between themselves and with foreign firms, has more to recommend it, perhaps in combination with regional and national efforts to create local feed-back from these alliances for extra-regional co-operation.

The international flow of scientists is still limited as compared to the flow of finance, capital and commodities, and stimulating the exchange worldwide might give a 'brain-gain' as illustrated by some of the Asian economies. Moreover, in certain fields, labelled as 'mega-sciences' by the OECD, international collaboration is necessary because of the enormous scale of the efforts to be made.

The regional, national and European levels regarding science-policy

The EU shows great diversity in the division of tasks between these three levels of government as regards public support for basic research. On the one hand, national governments still play a central role in devoting economic resources to basic research by funding research groups. The same can be said about the role of public national research centres and institutions, which have been reformed in recent decades by improving administration and scientific relevance within the national system, and which continue to be in the hands of national governments. On the other hand, there have been important trends towards decentralisation and Europeanisation of these public actions. The regional governments in some large federal or semi-federal European countries are in charge of the university system, and have increased their share of public support for scientific research (this is the case in Germany and Spain, for example). Europeanisation, as mentioned earlier in this report, became apparent with the creation in the mid-1980s of the two main European co-operation programmes, namely the EU Framework Programme, and the pan-European Eureka Programme, which have stimulated scientific co-operation across European borders.

These trends show that the 'national systems of innovation' are still valid and central to the European scene. National differences in scientific and technological performance are deeply related to questions such as the range of scientific research, the industrial structure, the educational system and the broader institutional set-up. These elements are never static, but in a continuous state of flux along with trends in European and global economies and societies. The recent trends towards decentralisation and Europeanisation of science policy has not reduced the importance of the national

systems, but, instead they are an important reminder of the limitations of the national level in an economy where innovation is accelerating.[22]

It is far from obvious to what extent the present division of labour in terms of policy responsibilities will and should change in the future. Moreover, it is not the purpose of this report to question the current political basis for the subsidiarity principle at national or EU level by giving a closed list of policy instruments or scientific areas which should be supported at each level. Rather, it is our goal to pinpoint the relevance of the trends we have mentioned, and to make some suggestions about how to grasp their positive elements through policy lines which can help to maximise the opportunities available.

The suggestions are based on two general points:

1. The EU level has a crucial role to play in supporting and guiding the growth of international and European collaboration involving different types of public and private institution in terms of basic science.

2. The sub-national, and more specifically the regional level, is increasingly becoming a crucial level of public action in this area due to the localised nature of scientific excellence as rooted in elements of tacit knowledge.

It has been argued that the problem of the EU is that it has a good scientific base but that it is weak when it comes to translating this into technological development and innovation. This 'technological gap' between Europe and its world competitors, Japan and the US, was the main political idea behind the creation of the collaborative schemes in the mid-1980s. How far is this still valid? And how have these programmes helped to narrow the gap?

A whole range of evaluation studies of EU programmes and Eureka have been conducted almost since their creation. Virtually all of them tend to find the impact of these programmes at national level positive (Sharp and Peterson, 1997). However, a different picture emerges when they examine the industrial impact of European collaborative programmes. Here there is an important paradox, especially for the EU programmes. The projects supported under these programmes should have a pre-competitive nature, as stated in the regulations, but they have been politically evaluated in terms of their specific contribution to improving European competitiveness (looking at the number of new products they have helped to launch, or the number of jobs they have indirectly created). The problem of this paradox is the way in which 'competitiveness' has been interpreted. It is no longer viewed as a process, but rather as a political objective in itself. The pre-competitive research supported by EU programmes:

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[22] For an analysis of national systems of innovation in the context of European integration see Johnson and Gregersen (1997).

"should be viewed as a sort of insurance policy to ensure that Europe has the technology and skills base to compete in the long-term; it can never be a panacea that delivers 'competitiveness' in the short-term. European technology policies may not have succeeded to date in pushing EU firms and institutes into the leading position in the development and application of all new technologies. However, they have *succeeded in encouraging collaboration between firms and research institutions across the EU. They also have opened up opportunities for upgrading knowledge and skills on the part of many participants, widening horizons and improving understanding and information flows. In this respect, European programmes have played an important role in shifting European firms and institutes out of their national champion 'bunker' mentality of the 1970s and early 1980s" (Sharp and Peterson, 1997).*

This analysis implies that the policy interest of the European Union has to move beyond the strict limits of the research programmes, and must develop further four general roles in the context of enhancing European basic science:

- mapping future trends in science and technology and making the maps useful for regional and national policy-makers through technology assessment and foresight;

- stimulating worldwide collaboration in science and connecting the leading European science groups with global networks;

- establishing mechanisms which enhance the quality of science of weaker regions and countries;

- forming a clearing house for learning about new modes of organisation of science and the use of science in innovation systems across the Member States, and also drawing on the experiences of non-Member States.

In addition, EU programmes should reinforce their European added value. To this end the box below suggests five policy prescriptions, which include other legal and policy areas of the EU.

EU added value in scientific programmes: five simple policy prescriptions.

- *More resources for basic research*, especially for projects, such as the genome sequencing programmes, where only a large body of coordinated research can bring the necessary critical mass of research to bear upon the problem. At a time when national governments are restricting the funding of basic research, the Union should consider whether the widespread benefits from such investment does not justify a more substantial EU role. If a critical mass of research is the basic goal, then there is no reason why large 'basic technological research' projects should not be organised within Eureka, with the EU contributing funds as appropriate, and with the participation of non-EU firms welcomed (provided they have significant investments in Europe).

- *More resources devoted to training and mobility programmes*, which help

to spread new ideas and technologies throughout the Union, and especially to the cohesion countries. Richer northern states, particularly those which make large net contributions to the EU budget, instinctively oppose such programmes and dismiss them as 'jobs for the Mediterranean boys and girls'. However, these programmes help expand markets for innovations, including those which originate in the more technologically-advanced North. Looking ahead to Eastern enlargement, training and mobility programmes will be crucial not only as political tools to extend the EU's technology policy acquis to the East. They will also allow EU research networks to expand and benefit, for example, from Hungarian excellence in mathematics or even Russian expertise in software, which developed during the Cold War largely because Russia's military hardware worked so badly!

- *Less resources for applications-oriented projects*, because dissemination-based policies offer a clearer rationale for a substantial EU role. Task Forces may be an appropriate way of amalgamating European efforts when the goal is as ambitious (and socially useful) as constructing the 'Car of the Future' or discovering vaccines to combat viral illnesses. The EU has an important role as a catalyst for such actions, particularly at sub-national level. Most applications-oriented projects are more effectively coordinated at a lower level of government.

- *More support for standards*, specifically high-level European standards and 'platforms', such as the GSM standard for mobile phones, which provide double benefits. First, they help to standardise procedures throughout the EU (and thus reinforce the Single Market), and second, if they are tough enough (as with GSM), they can themselves help to drive innovation.

- *Wider application of Eureka's 'bottom up' methodology*, particularly for programmes in biotechnology or environmental technologies which are likely to lead to the sort of 'basic technological research' which sharpens the internal research skills of firms. 'Top-down' methods have become familiar and rather comfortable for the Commission, but there is quite clear evidence to suggest that they are vestiges of an era which is now past.

Sharp and Peterson (1997).

We have seen how sub-national governments have become quite active also in science policy over the last two decades. This is not only due to the trend towards political decentralisation in many European countries over the same period, but also to the fact that locality has a crucial role to play in the learning economy. Chapter 2 showed the importance of tacit knowledge in the present accelerated innovation process, and how geography is important in the creation and development of this sort of knowledge through proximity. Regional governments have been aware of the economies

of localisation and have launched more or less explicit initiatives to enhance the innovative potential of their territory. Regional governments have good access to the local SMEs, universities and research institutions operating in the region, and are in better positions to effectively enhance social and economic conditions for the production of tacit knowledge. In close relation to this, the sub-national level is particularly well placed to reinforce the 'learning capabilities' of local institutions and the human resources. We shall look at this in Chapter 7 in the context of industrial networks.

Chapter 6: Innovation policy and new ways of organising the firm

Introduction

The most ambitious attempts so far to map the European situation in terms of science and technology (CEC, 1994b) and to compare its performance with developments in Japan and the US indicate that the substantial European investments in R&D and the excellent scientific results are not reflected in innovation and economic performance as measured by productivity growth rates (op.cit. p. 57-58). Why are European firms lagging behind in terms of innovation and productivity in spite of investing heavily in R&D? One possible explanation is slow adaptation by European firms to new organisational principles. The last decade has witnessed a dramatic change in what constitutes best practice in terms of organisational forms. Against this background it has been argued that the true Achilles' heel of Europe is that firms stick to old patterns of organisation (Andreassen et al, 1995, and Weinstein, 1997).

Results from TSER research, analysing patterns of production and trade specialisation and linking them to economic performance, indirectly support this view. Recent analysis of patterns of production and trade specialisation identifies weak European specialisation in high-technology (and high-growth) products (Verspagen, 1997). This brings organisational change into focus for two different reasons. On the one hand, the need for efficient modes of organisation promoting flexibility and innovation may be especially strong in economies specialising in products with a limited growth potential in world markets. On the other hand, weak performance, especially in information technology products, may reflect weaknesses in the organisational set-up of European firms (Weinstein, 1997, p.8), which means that one element in changing the pattern of specialisation could be to establish new forms of organisation.

This raises fundamental issues. Is there one best way to organise the firm in order to promote innovation and the intelligent use of technology? What should governments do to bring about organisational change? How can the diversity of organisational traditions in Europe be used to propagate forms of organisation conducive to learning and innovation? In this chapter we will reflect upon these questions from the point of view of the globalising learning economy, with special emphasis on the internal organisation of firm. In Chapter 7 the focus will be on the external relationships of the firms and the increasing importance of the formation of industrial networks.

We shall argue that one of the major consequences of intensified global competition and acceleration of change is that it challenges traditional modes of organisation and human resource development. The changes taking place in these respects are central to the very concept of 'the learning economy'. They indicate a great potential for promoting competitiveness, as well as negative elements in the form of social polarisation. Both must be taken into account in an updated policy agenda.

Intensified competition forces firms to find new ways of doing things

Many firms have experienced more intense competition in their product markets. For some it reflects a process of internationalisation and globalisation (automobiles, electronics and transport systems). For others it has been the result mainly of the break-down of barriers between sectors (banking, insurance and real estate). Sometimes the driving force has been a consciously engineered

deregulation pursued by public authorities, but more often the most fundamental factor has been technological development (such as new telecommunications and transport systems).

When facing more intense competition the pressure on firms to do new things and to change old ways of doing things is increased, although firms react differently to such pressure. Some will not make any changes and most of those will be wiped out by competition. Others will focus even more intensely on reducing production costs by intensifying the division of labour and reinforcing discipline in the factory. Others will try to find more intelligent ways of organising production with the emphasis on exploiting the new opportunities offered by information technology, thereby reducing costs and the time it takes to transform inputs into attractive outputs while at the same time obtaining higher quality products. Finally, some will try to find ways to side-step the competition by introducing new products and services or tackling completely new markets.

None of these strategies can be said to be the 'best practice' under all circumstances. In some sectors and phases of development, making the production process more effective – for instance by exploiting economies of scale - may be an adequate strategy, while in others success in the race to introduce new products is the most important condition for success. The same firm will often combine the different strategies in different mixes, and different mixes will prevail in different sectors, regions and countries.[23]

But even if there are several viable strategies many different studies, including some of the TSER projects, demonstrate that, at least in the OECD area, there are specific modes and mixes of modes which are tending to dominate in more and more sectors and firms.[24] This reflects both a selection process which picks the firms with the most efficient strategy mixes and a learning process where front-runners inspire laggards. We can see a broad movement toward new organisational principles that constitute a new best practice, especially in sectors characterised by rapid innovation and intense competition. It is in the most protected areas of the economy that the old organisational forms still thrive.

This implies that government policy has an important role to play in this area. One major opportunity for promoting competitiveness is to support organisational learning and to help individuals and firms to overcome barriers to change and to cope with the negative consequences of the organisational transformation taking place. This role will become even more important in the future, since some

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[23] Actually, we would argue that in the current period the most important factor determining the macro-economic performance of national economies may be the ability of the national system of firms to adapt to the new context of accelerating change and intensified global competition.

[24] This chapter draws on contributions prepared specially for this project by Phil Cooke and Gerd Schienstock, and on recent Danish research in the context of the DISKO project (Gjerding, 1996, and Lund and Gjerding, 1996) co-ordinated by one of the authors.

service sectors, which are heavy in terms of employment and have, so far, been immune from the intensification of competition, will become more exposed.[25]

The negative side of this process of organisational adaptation and innovation is that it intensifies selection mechanisms in the labour market, thus weakening the position of the comparatively unskilled and the slow learners (Lundvall, 1996). Without counteracting measures the very success of the adaptation process may be jeopardised by polarisation, which creates bottlenecks in the short term and undermines social cohesion and learning in the long term. This implies that policies promoting the introduction of new forms of organisation must give priority to enhancing the learning abilities of the low-skilled.

Main trends in modes of organisation and in skill requirements

The most successful strategies are obviously those which succeed in creating organisations able to cope with rapid change and able to impose change on their environment. Such strategies are at the core of the learning economy; they focus on the development of new skills, on competencies to cope with new problems and on developing new products when the demand for old ones is faltering.

It would seem that the basic distinction between firms that are most successful in these respects and those that are not is that the successful ones emphasise horizontal communication within the firm and build network relationships with external organisations. Both of these characteristics help give firms access to a diverse and rich knowledge base as well as the ability to change and expand it when faced with new challenges. Inside the firm it involves reducing the number of levels in the hierarchy and delegating responsibility to lower levels. It takes too long to move information and decisions to the top, and back again to the operational level, in a rapidly moving world.

Of course, this has consequences for the skills required by management and employees. One major task of management now is to select and motivate employees in such a way that they can and want to take responsibility and that they have the necessary social skills as regards communication and co-operation. Another major task is to support the creation of, and manage and renew, network

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[25] In the social sciences, there is sometimes a big gap between how different approaches treat the same phenomenon. One of the most obvious examples is the difference between how mainstream microeconomics and organisation theory view 'the firm'. In microeconomics the firms are seen as a 'representative' unit and differences between firms are neglected. In organisation theory the focus is on such differences and it is assumed that there are more or less efficient ways to organise production and distribution. In a period when there is radical change in best practice, the microeconomic approach is especially problematic because it neglects a substantial potential for economic growth. Organisation theory is often too casuistic to be theoretically useful and operates with too many competing taxonomies and conceptual schemes to be helpful for practitioners in the field. Evolutionary economics may be seen as one way of building a bridge between the need for general theory and differentiation in the organisation of economic activities. Dosi (1997) establishes a link between organisation theory and evolutionary economics.

relationships with external partners. Employees need skills which make it possible for them to cope with change in an interaction with others. This implies a combination of analytical tools, problem-solving based on practical experience, and social skills.

Where do the new organisational principles come from?

The new principles of organisation may be regarded from different perspectives, each with a different interpretation of why the new principles appear. The first contributions to the debate on the new organisational principles focused on organisation of the production and labour process (Piore and Sabel, 1984, and Boyer, 1991). New flexible production systems were identified where the emphasis was on the ability to respond to new market signals and exploit the flexibility offered by IT-based production systems. In the management literature, this debate was reflected in a growing interest for Japanese-based organisational techniques in the form of "just-in-time"/Kanban and quality circles. The overriding concern for the firm was to save resources and time and to obtain quality in a context of rapid change.

Another approach has a much more specific starting point, and refers to the formation of a new techno-economic paradigm rooted in information technology. It has been shown that, especially in connection with the successful production and use of information technology, there is a tendency to establish horizontal communication and functional flexibility within firms (Freeman and Perez, 1988). However, it was also shown that firms which introduced IT-based process equipment without introducing organisational change and human resource development achieved poor performance in terms of productivity (Lauritzen et al, 1996). This has been proposed as one major explanation of the so-called Solow-paradox: 'We see computers everywhere but in the productivity statistics'.

A third approach is based on the formal and informal participation of workers in decision-making and on the delegation of responsibility to individuals or to groups of workers. This approach emerged in particular from the Scandinavian debate on economic democracy and the quality of working life (Gustavsen, 1986). As unemployment has grown and labour has become less scarce, there has been a tendency to give it less priority in the debate. However, as we shall see below, it tends to reappear in a new form in the learning economy context.

The approach emphasised in the following presentation differs somewhat from those mentioned above. We are going to analyse organisational principles mainly from the point of view of innovation and learning. But, as we shall see, there is an overlap since information technology affects the process of innovation and learning and since specific forms of worker participation and production flexibility are important characteristics of the new organisational modes that promote innovation.

The new organisational mode as a framework for product innovation

One major reason why the new organisational principles become more widespread has to do with the need for firms to pursue product innovations. In spite of its absence in economic models, product innovation is not a marginal activity in the economy. It is fundamental for sustaining economic growth (Pasinetti, 1981) and in most sectors firms must introduce new products continuously in

order to survive. Empirical studies show that over a ten-year period, the majority of firms in most manufacturing and service sectors will have developed at least one new product or service.

The realisation that product innovations are most successful when there is close and efficient collaboration and interaction between different departments within a firm goes back many years and was one of the major outcomes of the Sappho-project (Rothwell et al., 1974 and Freeman, 1982). This study demonstrated that firms successful in product innovation were those with close internal co-operation between the production, R&D and marketing department. This is even truer today because of the accelerating innovation process. In order to reduce the time it takes to move from the general idea of a new product to launching it on the market, the efficiency of this kind of interaction has become of critical importance.

There are different ways to reduce barriers between business departments. One is to stimulate job-rotation between departments and another is cross-departmental co-operation in project-specific teams, which often will not respect old orders of seniority and the formal hierarchy. They will be free to communicate directly with other units, both inside and outside the firm, without referring back to the higher echelons. This form of network organisation is becoming more and more attractive, especially in fields with frequent product innovations (Sako, 1992, and Freeman, 1991). This does not apply only to high-tech producers, however. Producers of clothing, furniture and food-products also have to renew their products and to respond swiftly to new user needs, and indeed some business service firms have led the field in developing this kind of organisation.

New trends in skill requirements

The firms that have gone furthest toward the new mode of organisation are more demanding in terms of social skills and work virtues. When recruiting new employees strong emphasis is given to the ability to co-operate and communicate inside and outside the organisation. The importance of workers being prepared to take on responsibility and being trustworthy is also emphasised.

In a complex and rapidly changing context there will be more demand for knowledge aimed at solving a wider range of problems than for narrowly defined substantive knowledge. This gives academic training a more important role to play in forming the qualifications of the workforce. Other changes in qualification requirements are less clear-cut. Most of the firms introducing new organisational forms report a need for less specialisation, while a minority asks for more. It is probably the case that there is different demand for different kinds of knowledge. Technically there might be, at the same time, demand for highly specialised, multi-skilled and general workers. For all of these categories it is a requirement that they can communicate with people with a different kind of expertise.

There is growing demand for two specific sets of competencies and skills. Being able to use information technology and especially being able to learn as the technology develops has become a crucial condition in most parts of the labour market. More and more employees are expected to interact directly with foreigners, so linguistic skills and openness to other cultures is becoming more important.

Creating 'learning to learn' capabilities and environments

One important characteristic of the present phase of development is the extremely high rate of change in skill requirements. In the Green Paper on Partnership for a new Organisation of Work, it is pointed out that 80% of the process technologies used today will become obsolete within a decade (op.cit. p.7). This implies that all categories of employees and management need to renew their skills and capabilities from time to time and that organisations will continuously have to develop new competencies.

Hence a fundamental requirement is that employees have the background necessary to absorb new knowledge and to be creative in combining old pieces of knowledge in new ways. This puts new demands on education and training institutions. They should become much more focused on making students capable of confronting and solving new problems as they appear.

But it also demonstrates that much of the training and learning has to take place at the work-place or in close connection with firms. Some of the new organisational characteristics presented above are actually designed to promote the absorption, production and intelligent use of knowledge. But there is a specific problem of under-investment in this area, especially in areas where firms are many and small. The fact that the labour force is mobile means that firms will tend to invest less in people than what would correspond to a socially desirable level. This will be especially true for isolated small and medium-sized firms, while the situation might be different in industrial districts where the firms draw upon a common stock of skills in the region.

Japanese versus US principles of organisation

Much of the theoretical debate and management literature on the new forms of organisation has given the Japanese firm as a model. The combination of life-time employment, job rotation, interdepartmental task forces and horizontal communication practised in the big internationally oriented Japanese firms has been used as a prototype for the learning organisation in the new techno-economic paradigm (Freeman, 1987).

Recent analytical contributions give a new picture of the Japanese firm as a role model. The contributions by Nonaka (1991) and Nonaka and Takeuchi (1996) look behind the specific organisational forms and identify even more fundamental differences between the approach to organisational learning in Japan and the Anglo-Saxon tradition. According to Nonaka, the most fundamental difference is that the Anglo-Saxon model puts a much stronger emphasis on codified (as opposed to tacit) knowledge and that codification has become a goal in itself in the Western tradition. Japanese firms, on the other hand, tend to give the formation and use of tacit knowledge much more emphasis in the learning process, which is described as an upward spiral that moves between and combines tacit and codified knowledge. Nonaka (1991) gives a number of illustrations of how this takes place in connection with the development of new products, while Lam (1998) shows the difficulties when the Japanese model comes up against the Anglo-Saxon model in inter-firm co-operation.

While analysis of the use of tacit knowledge gives a better understanding of some of the weaknesses of the Western model for product innovation, the revitalisation of US high technology sectors and the slow-down in growth in Japan over the last couple of years have raised questions about the efficiency of the Japanese model and whether a different and more efficient model is developing in US firms (Weinstein, 1997). The major weak point in the Japanese model may be that it bars access to knowledge sources outside the firm. Intra-firm mobility of workers and experts may not be sufficient given the new mode of knowledge production. Inter-firm co-operation and the mobility of expertise between firms has become more important because of the growing complexity of the knowledge base and the acceleration of innovation. Intra-firm cross-functional teams have to be over-layered by 'integration teams', including experts from universities and from other firms (Iansiti and West, 1997).

These changes are reflected in changes in the position of the R&D department, which has had to show that it can interact with the market-oriented part of the organisation, and increasingly has to compete with external sources of knowledge. To do so it has to develop its own networks and alliances. The major challenge has become the timing of its output and the capability to create new products and ideas in a rapidly changing and increasingly complex environment. A statement by Bob Anderson from the Rank Xerox Research Centre illustrates this point (Anderson, 1997). After arguing that the most important change is not the increasing importance of the knowledge-base and intellectual property rights he goes on:

> *Rather what seems to be fundamentally different now is what you might think of as the second order derivative of innovation (the rate of change of the rate of change) – its cycle time, if you will..... In the marketplaces within which the outcomes of the R&D I manage are deployed, both the pace and the acceleration of innovation are startling; nay terrifying.*[26]

Bob Anderson describes the new context in which R&D laboratories operate as a "bazaar economy" where there is a mixture of formal and informal contracts and contacts and where new alliances are formed. A major task of management is to transform competitors into "co-opetitors". In the chapter on competition policy (chapter 10) we will return to the broader implications for industrial dynamics of these changes.

Organisational principles and national systems of innovation

It is important to note that international differences in modes of organisation are rooted in specific systemic characteristics and that any attempt just to copy what is going on in another national system

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[26] Anderson goes on to argue that the most extreme form of acceleration is the development of new services on the Internet. This is a perspective further developed by Fransman (1997) who shows that the Internet represents a new mode of innovation, which reinforces some of the characteristics of the new mode of organisation presented here by a magnitude. These include acceleration of the process and intensified competition reflecting simultaneous participation of many globally distributed innovators and a weakening of the distinction between the producer and the user.

is dangerous. For instance, national traditions in education and training, industrial relations and labour market regulation are fundamental for how specific organisational principles affect economic performance. To illustrate this point we could look at the role of life-long employment in some of the big Japanese firms and compare it with its extreme opposite – the Danish case.

In Denmark there are almost no restrictions on firing personnel and there is high mobility between jobs and employers. The Danish system, where most people are employed by small and medium-sized firms, promotes learning by a combination of other institutional characteristics. There is an extensive publicly financed system of training and retraining, there are possibilities to go on paid leave to obtain extra training, and the unemployment benefits are higher than in most other countries, so that workers' fear of change is reduced. The regular attacks from OECD labour market experts arguing that the high Danish benefits weaken incentives to accept low paid jobs illustrate the risk of focusing on one single variable rather than on systemic features. The fact is that participation rates are higher in Denmark than in any other OECD country. (In this context it is interesting to note that Paul A. Samuelson recently pointed not to Japan or the US but to Denmark as the ideal model.)

The main conclusion at this stage is that there is no single role model for Europe to copy and that any kind of policy initiative needs to take the existing systemic features as the starting point. We would however point to some features of the Japanese and US models which might be especially interesting when it comes to implementing the new organisational principles in Europe. The US model will, if left to itself, lead to extreme polarisation in terms of incomes and/or job opportunities, whereas polarisation has increased less in Japan than in other OECD countries (OECD, 1994b, p.23). This may reflect several distinct features where the two systems differ. Here we would emphasise two differences between the models: life-time employment and a difference in the appreciation of tacit knowledge.

In the new context it may be counter-productive to implement life-time employment – especially in economies with a strong presence of small and medium-sized enterprises, and here a Danish model (combining flexible employment contracts with generous unemployment benefits and attractive training opportunities) may be more adequate. On the other hand, it is worth considering that the one-sided focus on formal and codified knowledge may be a major factor in reinforcing polarisation in the European labour market. If so, more emphasis on the formation and utilisation of tacit knowledge in connection with training, production and innovation systems would help to give those with little formal training a better chance.

European diversity

There is no systematic mapping of differences across European countries as to how firms use different organisational forms. Most studies have been based on case material and it is only recently that attempts have been made to analyse international differences in these respects in a more systematic way (Foray and Lundvall, 1996b, p.135-189 and Berger and Dore, 1996). However, the scattered evidence that there is indicates substantial differences between the European countries.

One area where some documentation of international differences exists is in relation to worker participation. Survey data show that there are substantial differences in how, and how far, workers participate in the process of organisational change (EPOC, 1997). For instance, direct participation

through workers' representatives is quite frequent in Sweden and Denmark and much less so in Portugal, Italy and Netherlands (op cit., p. 32).

If the focus is shifted to government initiatives to stimulate worker participation, we see a similar picture where countries with relatively strong traditions of participation (Denmark, Sweden and Germany) initiate public programmes to develop participation further while those with low degrees of participation (Netherlands, Italy and Spain) have no public initiatives in this direction (Latniak, 1995).

This example illustrates a major problem for community-wide programmes to promote new forms of organisation (see the Green Paper on partnership for a new organisation of work – CEC, 1997a). The very uneven development implies that such initiatives must take different forms in different countries. The most advanced countries in this respect may be prepared to initiate programmes that move organisation of firms toward quite sophisticated forms of interaction and learning, while those lagging behind need to try out co-operation in small-scale experimental forms.

Worker participation in the context of learning organisations

The dimension of worker participation is important in relation to the learning economy since learning organisations have to build on delegation of responsibility to individual workers or to teams of workers. It is also important in the sense that it is difficult to implement organisational change without a minimum of support from employees. There are thus inherent forces promoting at least informal participation. This does not imply that the traditional forms of formal representation – trade unions and shop stewards – will necessarily gain or lose in terms of power. But it indicates that changes will take place and that these institutions need to adapt themselves to the new context. In a Danish survey, managers in a majority of firms pointed to formal co-operation with trade unions as a positive factor rather than as a barrier to organisational change (Lund and Gjerding, 1996).

But diversity is also a potential source of innovation. There are unique opportunities in Europe to exchange experiences in this field and to learn from the experience of others. The potential can be fully developed only if the following three prerequisites are fulfilled: mapping of organisational forms across Europe, evaluation of the systemic context for each country and a better understanding of the linkage between organisational forms and economic performance.

Public policies to support the introduction of new modes of organisation and human resource development

It might be tempting to argue that the organisational set-up of firms should be left to the market-place and the managers to decide. How can public policy-makers 'know better' than the insiders? The answer to this question is, of course, that they don't. But this does not exclude a role for governments.

The LOK project

In 1998 and 1999, the Danish government will implement 10 initiatives aiming at promoting organisational and managerial change in Danish businesses. The initiatives are the outcome of a two-year dialogue process including businesses, social partners and academic bodies.

The central idea is that although a flexible work organisation can only be achieved by firms themselves, organisational change is intimately related to a firm's wider social environment, which defines access to knowledge, information, skills and exchange of experiences.

The initiatives focus on the development of new competencies and services in public and semi-public institutions (i.e. universities, business schools, training institutes and technical institutes) interacting with businesses in matters relating directly or indirectly to innovation.

- *Further education for consultants*. The point of departure is a recognised need for competence-building among consultants, in areas such as communication, interactive skills, and understanding of links between functions within enterprises. Moreover, a new information service on consultancy services will be established in order to increase market transparency.
- *Local advisory units on vocational training* will be established in order to deal with business needs for individual training programmes. The units represent local training institutes and make possible a closer link between organisational change, skill development and training.
- *A research centre on management and organisational change* will be established. The centre will facilitate co-operative research projects focusing on the flexible organisations of tomorrow. Businesses will be invited to participate in a number of activities, including co-operative research, training modules and development of tools and methods to change management in SMEs.
- *A research project on "knowledge accounting"* will be initiated. The projects brings together scientists, businesses, investors and trade associations. It aims to integrate human resources and other intangible assets into accounting principles in order to make possible proper valuation of knowledge-based enterprises. Furthermore, the principles are to be used as internal guidelines and steering methods in flexible organisations.

In order to facilitate co-operation between regional institutions and private enterprises, a "Change Contract Scheme" will be designed to allow the co-financing of regional projects, including at least two public institutions and a number of enterprises. The projects will focus on issues relating to organisational change, i.e. competence building in work teams, how to build a learning organisation, networks and standards for interactive training. (Jens Nyholm, 1997)

Governments may help in different ways. The recently established Danish LOK (Management, organisation, competence) programme, bringing together four different ministries, makes a major effort to create new framework conditions to stimulate organisational change in firms. In other

European countries where awareness and the implementation around these issues are still of a more preliminary nature, less ambitious initiatives aimed at analysing the actual situation and the potential for different types of policy initiatives may be called for.

The most powerful tools to influence organisational change are policies affecting the pressure for change, including competition policy. But in a sense, these tools might be too powerful. If the system of firms exposed to intensified competition is not at all prepared for reconstruction, the outcome may not be creative destruction but just plain destruction. Competition pressure must match the ability to absorb change, which has to do with human resource development.

Public policy in relation to human resource development

The new organisational context points to new tasks for the formal education and training system. First, it is obvious that there is a need to increase the effort in certain fields, such as providing skills in using information technology and in communicating and co-operating across national borders.

It might be difficult, and even of dubious value, to train students directly in social skills such as co-operation, and in work assets such as creativity. But there is ample room to introduce work and study methods and evaluation schemes that reinforce and develop such skills. For instance, basing training on problem-oriented and interdisciplinary projects pursued in groups with common evaluation for the group is a way of simulating how things are done in the real working life in the learning economy.

The need to engage in life-long training will require other institutional changes. A crucial element will be to involve private firms in more direct co-operation with the public sector. Public schemes could support training in firms in order to avoid under-investment, and could give support to groups of firms joining with each other and with regional training institutes to develop new programmes for building the skills needed. And most importantly, public programmes could be introduced to explain to firms in general how to organise learning.

The need for a New New Deal

The learning economy is one where broad participation in economic activities and trust is fundamentally important for economic performance. When the workforce is required to master more skills than they are capable of learning, the result is the exclusion of citizens from active participation. Trying to bring unemployment rates down in such a situation will give rise to inflationary bottle-neck problems in the labour market. Safeguarding a high level of trust in a strongly and permanently polarised economy may also be difficult.

For these reasons, as well as for social reasons, a whole set of specific measures to support the low-skilled and slow learners is needed. A New New Deal must focus on the distribution of learning capabilities, involving both ordinary education, and training institutes and firms. Giving special incentives to low-skilled workers to go on leave in order to develop general and specific skills, and to bring in unemployed of the same category in their place could be part of such a programme. It is also important to review the existing training methods and try to find new ones which are especially

adapted to these groups, including programmes more focused on giving a more positive role to practical skills and on tacit knowledge. It is especially difficult to motivate older workers to engage in training and here, exceptionally, the solution may be to create sheltered jobs less demanding in terms of learning. However, the main strategy should be to create a cohesive labour market and, as far as possible, to avoid exclusion and polarisation.

Dividing policy responsibilities between regions, nations and the European Union

Organisational innovations differ from technical innovations in that they are more 'fuzzy'. There is no legal protection - such as patents or licences - for new forms of organisation so incentives to document and specify them are weak. This may be one reason why firms tend to underestimate the importance of organisational as opposed to technical change. It is also reflected in a general lack of understanding of society as a whole of the organisational systems used. The division of responsibilities between the three levels of decision-making must take into account these characteristics of organisational innovation. It must also reflect the very uneven development and diversity on the European scene.

All these factors imply a major role for the European Commission in organising the knowledge base in this field. The situation is similar to that of science and technology some decades ago. There is a need to establish common principles to gather and present data (cf. the roles played by the Frascati manual and the Oslo manual in relation to R&D and innovation statistics). The very uneven development in the field in Europe presents analysts with a diversity that may be helpful when it comes to developing taxonomies and related policy strategies. This is an area where the TSER programme could help by promoting basic research. The recent launch of the 'Made in Europe' project (Coriat, 1997) is an important step in this direction.

This analytical effort must take into account that organisational features even more than the use of technology are rooted in systemic features specific to regions and nations. Industrial relations, the education and training system, the financial system and other institutional characteristics of the national innovation system have to be taken into account when designing policies aimed at introducing new principles of organisation and human resource development. In this field the comparative approach is extremely useful, since it creates an awareness among policy-makers and agents for change of the characteristics of national and local systems. Such awareness is crucial for designing policy.

This implies, on the other hand, that the policies must be designed and executed mainly at national or regional level. This is an area where the starting point is different for each country and region so the challenges presented by globalisation and the learning economy will differ. An economy dominated by small and medium-sized firms in low-technology sectors will need a completely different approach to one where big highly internationalised companies dominate. Some regions - like industrial districts or local industrial clusters – will have there own specific organisational traditions and therefore the policy should also allow some scope for regional initiatives.

The fact that organisational forms and human resource development strategies are embedded in national innovation systems has another important implication. To implement the new principles of organisation some of the existing policy frameworks and institutions may have to be changed. This is

a major point made in the Commission Green Paper on partnership for a new organisation of work. But again the critical framework conditions and institutional barriers will differ between countries and therefore policy strategies will have to be rooted at national or regional level.

A specific effort is needed in the field of human resource development in order to counter the tendencies toward social polarisation. Since this trend is general in all countries there is an argument for the European Commission to take a lead here. A European forum for exchanging experiences between countries and regions regarding the experimental design of human resource development systems to support weak learners is a possibility. Education and training systems are conservative and real incentives to try out bold experiments in this field should be provided. Different models of production-based training where learning is integrated into the everyday life of private firms could be developed and tested within such a forum.

Chapter 7: Creating networks and stimulating interactive learning

Introduction

In the last chapter we pointed to organisational change as a new focus for European innovation policy. Another way of more effectively transforming the European knowledge base into economic growth and job creation is to stimulate the formation of networks. This is an area where European innovation policy has already played a role through the ESPRIT Programme, the Framework Programmes and, indirectly, through the EUREKA Programme. But networking is a phenomenon that can be stimulated at different levels – from the local and regional level to the global level - and it is an area where policy options are complex.

A number of questions arise in relation to policies aimed at stimulating the formation of networks, namely, what is the nature and dynamics of innovation networks? What is their relevance within the new industrial dynamics at European and regional level? What are the most significant risks and costs of networking for the individual firm and for the system? How can policy action tackle those?

Co-operation and competition between firms and other innovative units coexist. Horizontal forms of co-operation, between competing firms or between firms and research centres, have expanded in the last couple of decades. They are generally based on contractual agreements to undertake common R&D activities, where the commercial exploitation of results is carried out independently by each partner. Thus there is co-operation in the research (and in some cases the developmental) phase, while there is competition on the final product market. Vertical arrangements are where users and producers co-operate in defining and improving products or production processes through buyer-supplier relationships.

This chapter considers the global and regional dimension of networks. It will address some of the previous questions, by focusing on two central points, namely, the role of innovation networks dynamics in the learning economy, and the policy implications emerging from this and from some interesting policy experiences. Chapter 8 will consider certain aspects of creating vertical linkages and inter-firm co-operation from the perspective of (government) technology procurement policies.

Networks and inter-firm co-operation[27]

One salient feature of the new mode of knowledge creation is that more and more of the innovation process takes place through networking rather than through hierarchies and markets. Data based on the European Community Innovation Survey, CIS, show that only a small minority of firms and

[27] This section is based on the contribution of Prof. Philip Cooke. See also publications by the Cooke TSER project on regional innovation systems (Cooke, 1997, Cooke, Etxebarria and Uranga, 1998 and Tödtling and Sedlacek, 1997).

organisations innovate alone, and that most innovations involve a multitude of organisations (DeBresson, et al, 1997).

Innovation Networks

Networks bring together formally independent organisations in long-term relationships involving information exchange, interactive learning and direct co-operation. In economic terms they may be constellations of 'untraded interdependencies' but they are also constellations of social relationships. Network forms of governance are preferred to markets or hierarchies because they give more flexibility, and a broader interface for interactive learning, than in-house interaction, and a more stable and efficient base for coordination and interactive learning than the anonymous market.

Networks and network relationships are heterarchical rather than hierarchical. They are based not on bureaucratic or administrative authority, nor on arm's length market exchange, but on exchange between partners of consequence. The importance of horizontal inter-firm co-operation in promoting innovations highlights the qualitative aspects of networking. Grabher argues that "loose coupling within networks affords favourable conditions for interactive learning and innovation. Networks open access to various sources of information and thus offer a considerably broader learning interface than is the case with hierarchical firms" (Grabher 1993).

Networks lower transaction costs by substituting exchange through reciprocity for exchange through markets. They may suffer from "lock-in" where insufficient "loose-coupling" or network exchange, openness and interaction are available. They may be set up temporarily to solve a problem experienced in an industrial community. They need not be permanent and from time to time they divide in order to coalesce with new partners. At their most functionally efficient they are capable of allowing rapid and reflective response to anticipated or actual crises affecting firms, social groups or cultural communities (Freeman, 1991).

Network relationships are based on a number of key social and psychological features:

- reciprocal exchange relationships among partners
- trust in the integrity of partners
- belief in the reputation of partners as persons of conscience
- understanding of need for openness and willingness to learn
- a personal disposition that is inclusive not exclusive
- a political disposition that is empowering not elitist

- shared customary conventions or rules of the game.

This list shows that networks can thrive only if there is a minimum of mutual trust in the relationships. Without trust the costs of designing and supervising contracts (transaction costs) would be prohibitive. This implies that *networks are always socially embedded.* They are discursive mechanisms for creating and accessing tacit knowledge.

Network stability derives from the establishment of trust and reliability, reputation and customary rules to which members adhere. The reason for maintaining networks is that network members have direct or indirect access to resources and influence in pursuing projects they consider to be individually or collectively important. Network actors need each other because within their own institutional setting (e.g. firm, university, research laboratory) they cannot create all the resources they need, whether financial or intellectual. Thus, networks are always distinct from markets and hierarchies. Although they can be based on legal contracts and involve financial transactions, they are conditioned by notions of reciprocity, sharing, co-operation and trust as means of economic coordination.

Networking takes different forms. *Horizontal co-operation* between competing firms or between firms and research centres has expanded tremendously in the last couple of decades. It is generally based on contractual agreements to undertake common R&D activities, while the commercial exploitation of results is carried out independently by each partner. *Vertical linkages* between users and producers for the definition and improvement of products or production processes have also become more frequent and more comprehensive over this period. The growing importance of selective relationships between customers and sub-contractors, giving them a more direct role in the innovation process, accounts for the formation of regional, national and international production chains.

The regional and local dimension of networks

The local and regional dimension of networking is crucial. The learning process within an innovation network is based upon a constant exchange of knowledge, as well as the collective production and exploitation of new knowledge, founded on mutual trust. In this sense, the territorial dimension of networking activities is not a subsidiary factor, but rather a primordial one. Networks function best as innovative social organisms when they exploit the different areas of tacit knowledge of regional or local interests and associations, including firms and enterprise support agencies. This is partly because the exchange of tacit knowledge requires more trust and cultural understanding, developed mostly through geographical proximity. Networks can also be international or even global, and the frequency of these wider networks is growing rapidly, but normally wider networks will tend to be more formalised and oriented toward the exchange of codified knowledge. The Keeble TSER project recently concluded that notwithstanding their global market orientation and international research

links, European high-technology SMEs are also frequently part of regional knowledge networks involving other regional firms and knowledge centres.[28]

Networks exist in specific institutional milieux or settings with shared interests and understandings (Castells and Hall, 1994, and Saxenian, 1994). Therefore, the way in which networks specifically contribute to the development of the innovation system will depend on the type of institutional setting or milieu, and the interaction between it and the networks.

The innovation network can be differentiated from the innovative milieu:

- the **innovation network** is an explicit organisational co-operation and exchange arrangement aimed at the development of knowledge, products or services
- the **innovative milieu** is the existing regional capacity, in a more institutional sense, that gives rise to the potential for innovation networks to flourish.

Studying systemic learning and networking implies a broader understanding of the institutional setting and its relationship with industrial dynamics.

The **regional dimension of innovation networks** is crucial for these reasons:

- The capacity for developing human capital, as well as interactions between firms, schools, colleges and those responsible for vocational training is normally localised;
- networks of formal and, more usually, informal contacts between network members are made possible through casual or planned meetings, information exchanges and customer-supplier relationships;
- synergies, or an innovative 'surplus', can emerge from the shared cultural, psychological or political perspectives of those engaged in the same specialisation in the same economic space or region.

Policy and public sector players are important elements of the milieu in which networks operate. Not only does the specific policy strategy affect industrial dynamics, but so does the constellation of public and private sector players who participate in the decision-making of such policy strategy.

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[28] TSER project coordinated by Dr Keeble. Keeble, D and Lawson, C (1997): Networks, Collective learning and RTD in regionally clustered high-technology SMEs (unpublished TSER draft report).

Therefore, the forms of this partnership between local policy-makers and private sector players is an important element in the regional innovation system.

In relation to these three broad arguments, the establishment of innovation networks is currently perceived as an essential policy instrument to enhance the technological capacities of *less favoured regions*. Networks help these weak regional innovation systems in three crucial ways:

1. by building up the 'social capital' in the region, exploiting the learning potential of individuals and human resources;

2. by expanding the (generally very weak) institutional capacities of the region;

3. by enhancing partnerships between public and private sector players in the region, and devising collective strategies.[29]

The costs and risks of networking

The previous section discussed some of the potential benefits of networking for innovation. Assumptions were based on the idea that networks, as non-market and non-hierarchical forms of industrial organisation, reduce costs of communication and transaction, and facilitate interactive learning. However, even if they do this for a while, they might later become obstacles to necessary change. And there are other costs and risks, both for individual partners and for the innovation system as a whole.

Four negative aspects of innovation networks, which may apply to a greater or lesser extent, are the following.

1. Networks might increase, rather than reduce, transaction costs as it takes many resources (economic, human and time) to build the networks and operate them effectively.

2. The presence of free-riding partners reduces the collective benefits for the rest of partners

3. Networks contain an important element of inclusion, but also of exclusion, which can have a negative effect in the territorial or sectorial dimension.

4. Power relations within the network might be less than ideal and may strongly influence the network. For example, large companies might dictate the directions of the network's operations, or exploit the knowledge produced locally rather than contribute to local knowledge-creation.

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[29] Following these premises, the EU has recently developed 'Regional innovation strategies', a policy instrument managed by DG XVI that aims to develop these collective strategies in less favoured regions of the EU.

Besides these costs and risks of specific networks for the individual partners, networks might also have important negative effects on the overall innovation system. This is related to what we identified in a previous chapter as the *integration/flexibility dilemma*. While networks are effective mechanisms for integrating individual firms and organisations into the innovative system and in pursuing a specific technological trajectory they may, at a later stage, become mechanisms which prevent those firms from adapting to new conditions. Networks might work as factors introducing systemic and technological lock-ins into the process if their capacity for change is limited, and the financial commitment invested in building information channels and trust makes it too expensive to end the collaboration. This can apply especially when scientific paradigms or the technological trajectories of the innovation process change rapidly and radically. In such situations, radical change in the environment may make given network constellations inefficient and block renewal of the economy. For instance, one reason why the positive impact of information technology on productivity took a long time to appear may have been the stubbornness of old networks linking industries to mechanical engineering (Lundvall, 1993).

This dilemma also has a geographical dimension. Regional networks and industrial districts may be important for stimulating knowledge-creation locally. But wider networks may be more dynamic, and being locked in regionally may hamper the innovative capability of firms. This may be specially true for European-wide industrial networks. The recent rejuvenation of the US high-tech industries has been closely linked to the formation of international production networks spanning several continents and especially involving producers in South-East Asia (Ernst, 1997; Borrus and Zysman, 1996).

Public action has a role to play in this dilemma, by ensuring that the risks and costs of networking are minimised, not only for the individual organisation, but especially for the overall system and innovation process. However, before examining this point in detail, the next section will briefly review some of the most salient policies adopted in Europe at different levels of policy-making.

Policy experiences with networks[30]

The literature focusing on innovation networks sees innovation as an interactive process. Communication, co-operation and coordination between actors are conceived as essential elements in the innovation process. This has changed the perspective on innovation policies in the last two decades from one which stressed infrastructures to one which stresses the fostering of interaction between actors, firms and other organisations. This may be referred to as *the network approach to innovation policy-making*.

Europe has lately seen the emergence of several inter-firm collaboration and network initiatives. A large variety of public programmes to support networks have been launched in the last decades with the purpose of stimulating interactive learning by enhancing linkages between firms and between

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[30] This section is based on the contributions of Prof. Philip Cooke and Dr. Patries Boekholt respectively.

firms and the R&D infrastructure. The mechanisms of these policies, the scale of the networks, and target groups differ largely from case to case. They are the initiative both of national policy-makers concerned about the unsatisfactory exploitation of RTD capabilities by industry and regional policy-makers aiming to exploit fully regional capabilities for economic development.

The *European Commission* has also contributed to the spread of the collaborative network approach in two major ways: through the funding of pre-competitive RTD conducted by transnational consortia of firms and research centres (the ESPRIT programme laid the foundation for this mechanism to become the dominant form of EU RTD support), and through the establishment of multiple transnational networks for technology transfer and dissemination (CEC, 1994a).

Several European countries have developed networking policy instruments at *the national level.* A common form of networking policies are schemes that link groups of firms with research centres and universities. One example is the Dutch BTS (Business-Oriented Technology Collaboration Scheme) launched in early 1997, which funds collaborative projects for up to 37.5% of the costs. This mechanism is very similar to the pre-competitive research funding in European programmes. However, the Danish Network Programme launched in 1989 is the best known national co-operation programme in Europe. In its original design the scheme consisted of awareness-building, brokerage-training and grants for establishing networks. The active marketing of this programme by the Danish Technological Institute has led to the wide application of the model in other countries such as Portugal, Spain, the UK and Ireland, which have adapted it to their own requirements.

Similarly, a large set of networking initiatives have been launched at *the regional level* in the past decade. Given their limited scale and public budgets it is not appropriate to include all the elements that are available on the national scale. So for regional innovation policy there is greater pressure to target specific economic and technological strengths. This is the reason why regional innovation policy is increasingly focused on building network infrastructures between existing parts of the regional system: technological support systems, support for interfirm collaboration, promoting research and development in endogenous firms, and linking local firms with internationally operating firms. Cooke (1995) refers to this new approach to regional development as the idea of networked regional innovation architecture.

These regional initiatives, more than the national networking programmes, aim at improving the innovation capabilities of SMEs, and not solely at creating industry-RTD linkages. Small and medium-sized enterprises, even when operating on a regional market, feel the challenges of global competition in the same way as large companies operating internationally. One obvious effect is for instance the change in subcontractor relationships: contractors require higher quality, more flexibility and more complex products from their suppliers. The SMEs find it increasingly difficult to face these challenges by themselves. Therefore, the rationale of regional policy initiatives has been based on the idea that inter-firm co-operation can offer:

- Better channels for *learning and creating expertise in the region:* It is widely accepted in innovation research that companies rely heavily on other firms - their competitors, suppliers and customers - for innovative ideas.

- *Economies of scale in the region*: Networks aimed at joint purchasing, distribution, or sharing of facilities can reduce costs for individual firms;

- *Economies of scope in the region*: Combined expertise can open new market niches for high-end, value-added products. A network of firms with complementary expertise could be better equipped to deal with demand for high-quality products and services if they combine their skills;

- Heightened *flexibility and shared risk in the region*: Creating a pool of expertise in a flexible network increases the ability of the regional economy to respond to the demands of the market.

Types of support mechanism[31]

Schemes for enhancing innovation networks have assigned a number of different roles to public action in this area:

- promoting awareness;

- facilitating of informal contacts and thematic working groups;

- helping to bring firms together by supporting brokerage;

- supporting collaborative facilities and technical services;

- providing financial support for networks and interfirm co-operation.

Following these goals, there are different types of policy instruments and programmes for enhancing collaborative networks. In 1993 a review of European policies for networks was conducted on behalf of the European Commission's DG XIII,[32] identifying a range of networking policy approaches (Boekholt and Fahrenkrog, 1993). A basic distinction was made between policies aimed at sustaining existing networks and those aimed at creating new linkages. In the first case the main challenges are to revitalise existing modes of operation and facilitate innovative approaches in mature industries. In the second case, promoting awareness, finding and bringing together the appropriate partners and building a relationship between them are key issues. The review identified 23 policy initiatives in Europe, most of them oriented towards SMEs, while others involve a deliberate mix of small and

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[31] This section is based on a contribution by Dr Patries Boekholt.

[32] This review was conducted under the framework of the European Innovation Monitoring System (EIMS). It served to prepare one in a series of Policy Exchange workshops where policy-makers from each EU country could learn from experiences in other countries.

large firms. The collaboration can also involve knowledge suppliers (RTOs, Universities, Technology Centres) and other types of intermediary.[33] The schemes can be classified under three headings:

1. Formal co-operation versus informal co-operation

The type of networking schemes identified in the EIMS review varied from linking firms in an informal matter (i.e. business clubs, mentorships, joint seminars) to very formal co-operations backed by contracts and joint ventures. The philosophy behind the informal approach is that building trust takes time and should start with 'easy' forms of collaboration before companies start sharing more sensitive information and skills.

Examples of this informal approach are the Plato Scheme in Belgium, and the Medical Technology Forum in Wales. The first has been run by the Kempen Regional Development Agency in Flanders since 1988, and aims at knowledge transfer between SMEs and large companies through mentorship groups. The final objective is to develop more formal networks between 'allied enterprises'. The Welsh Medical Technology Forum was founded as a collaborative venture between industry, the Welsh Office, the Welsh Development Agency, the National Health Service and academia. Its mission is to improve the competitiveness of the medical sector in Wales. The Forum has an industrial chairman and representatives from industry on its steering group. More than 90% of all health care companies in Wales have participated in seminars and workshops since its launch in 1992.

The rationale for the formal approach is that co-operation between companies should not be free of obligations and should aim at establishing clear objectives and milestones. The philosophy is that firms will only invest time and effort in networking in return for clear business benefits. A recent example of such an approach is a Dutch initiative in the region of Twente, where around 60 specialised suppliers and contracting engineers from all disciplines have set up the Systems Supply Group Twente Ltd (TMG). The group has formalised this network by forming a new joint shareholding company, which acts as systems supplier contractor on behalf of the shareholders. The public role in this initiative consisted of financial support for the brokerage efforts and an initial payment in shareholder funds. Joint research and product development between the firms is expected in the longer term.

Whether formal or informal co-operation works best depends on the degree of previous networking experience of the target group. In cases where the companies already know each other or have experience in establishing interactions with external knowledge suppliers, the slow awareness and trust building phases can be shortened. This was the experience in the Danish Network Programme where some of the networks were consolidated into formal joint ventures. In regions and industries

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[33] We should explain that, given the relatively short time for the EIMS review, it concentrated on the national policy level, and included only a selection of interesting regional initiatives. The focus on SMEs resulted in under-representation of R&D-oriented collaborative networks. In several countries programmes are designed to foster industry research relations and increase user orientation of R&D. These were not taken into account in cases where the target group was mainly medium to large companies with R&D capabilities.

where collaboration is not so well developed, the informal route may be more effective in prompting firms to establish interactive links.

2. Vertical versus horizontal inter-firm links

Those who practice and study networking often claim that networks of competing firms are not viable. Trust between companies cannot exist if the network members are direct competitors. Indeed, the EIMS review identified mainly vertical, supply-chain-oriented initiatives. Here the aim is to increase the performance of the suppliers, to raise their quality standards, to increase co-designing capabilities or even to become joint system suppliers. More informal networks can bring together groups of firms from completely different sectors sharing similar technological or innovation management issues. However, there are also network approaches that associate competitors from the same sector, for instance in industrial districts where many small and medium-sized firms operate in the same sector. The Italian CITER Programme initiates network projects among textile firms to provide the firms with strategic information about fashion, market and technology developments. The Germany Technology Working Groups (Technologie Arbeitskreise) is joint technological problem-solving for firms in the same sector. In areas where there is no historical tradition of co-operation, severe pressure from global competition is often one of the incentives for competitors to co-operate.

3. Brokerage activities versus building a collaborative infrastructure

In the brokerage approach the public role consists in identifying potential partners and bringing them together for more formal co-operation. Experiences with the Danish Network Programme have shown that this facilitator role is difficult and requires specific expertise and good knowledge of the business community. This is why training of brokers plays a key role in the programme. Recent initiatives in the Netherlands where Innovation Centres have played a similar role in bringing together firms for 'cluster projects' on joint product development, also showed that this takes a long time and is very time consuming. Thus public investment in these type of activities is likely to be substantial.

Instead of proactively bringing together firms, network initiatives can consist in building collaborative service infrastructure with specific expertise. These centres can act as problem-solving and technology-watch facilities. The firms themselves are left to take the initiative to use this infrastructure in collaboration with other firms. The Italian CITER programme is a good example of such a joint service infrastructure. One of the important policy issues here is the degree to which the users are in control of the services provided. Many public initiatives seeking to provide these services which have been started from research centres or universities have shown limited dissemination potential.

Public schemes - rationale and lessons

Even a limited review of networking policies shows the wide variety of support mechanisms, target groups, and objectives involved. The fact that a majority of these initiatives are developed at regional or even local level is due to the need to fine-tune the business sector, the support infrastructure and the people involved in the process. This implies that there is no 'best practice' recipe for network policies or instruments. However, some *general lessons can be learnt* from the types and examples of networking described above.

1. Network brokerage is a specialist task which can best be performed by actors close to the business community who are widely accepted as intermediaries.

2. Creating networks relies on raising awareness and building trust, and it is a process that takes time. Public schemes that need to show short-term results may be difficult to legitimise.

3. From the firms' standpoint, clear business benefits should be expected before they will commit time and effort to networking, particularly in more formal modes of networking.

4. Science-led initiatives to foster clusters with economic potential have resulted in only a few success stories.

The issues of how to identify potential successful clusters and how to manage the creation and growth of these 'centres of competence' are on the agenda of many national and regional policy-makers at the moment. The costs and risks for individual organisations of engaging in networking activities are among the main reasons for the establishment of these public programmes. Firms run the risk of losing important know-how in networks, while exposing themselves to the competitors. Thus there is not much incentive for individual firms, specially SMEs, to engage in collaborative arrangements. As shown in different examples, public action can help create the conditions for trust and confidence between partners needed in such situations. Similarly, public action can help to reduce the time and resource-consuming activity of setting up a network through schemes that aim to improve the efficiency of this initial stage. And finally, by acting as a direct broker or information provider, public action can help individual firms find a suitable partner, or help a group of firms identify common problems and challenges.

Similarly, the purpose of public action should not only be to encourage individual firms to join and set up innovation networks, but should also be to identify potential negative effects of networking in a given system and/or technological trajectory. In cases where the integrative impact of the networks has a negative side by producing technological bottlenecks and hindering the adaptability of individual firms, public action should be able to detect such problems and to promote the development of alternative networks in areas and in forms which are more flexible. In other words, public action should focus on disintegrating and reintegrating networks in the territory, to some extent producing discontinuity in negative networking trends. This requires that policy-makers are prepared to introduce policy alternatives which give new direction to traditional industrial and technological orientations. This is one reason why it is becoming increasingly crucial at the regional and national level to encourage firms to participate in international and global networks.

Chapter 8: Knowledge-intensive services in the learning economy

Introduction[34]

As pointed out in the introduction to this report, studies of innovation processes and public action on technological development have tended to focus mainly on manufacturing activities. Services have generally been given only marginal consideration. Aware of this unbalanced view of the learning economy, several of the TSER projects are currently examining the role of services, especially knowledge-intensive services, in the innovation process. The analysis has important implications for the European project which have been overlooked. As we shall see below, firms involved in producing knowledge-intensive business services play a major role in international integration processes because they transfer experience, institutions and technologies between localities that are geographically far apart. In this sense, they are at the very core of the globalising learning economy.

The economic and organisational activities that come under the generic term 'services' are very diverse and heterogeneous. This has traditionally posed a problem in analytical and statistical terms, and has so far prevented an analysis of the role played by this sector in the recent transformation of the economy. Extensive conceptual and comparative tools need further development. Most of this chapter is based on the provisional results from TSER projects, and will address some of the questions relating to their line of inquiry. How do knowledge-intensive sectors affect organisational change, and the dissemination of tacit knowledge in the innovation system? How are those knowledge-intensive sectors defined and in relation to which industrial sectors are they most relevant? What are the policy implications of the role played by knowledge-intensive services in the learning economy?

The interaction between services and manufacturing

It has been generally claimed that the literature on economic growth and technological change has traditionally been biased in favour of manufacturing and against the service sector. However, this charge of a 'manufacturing bias' is not totally correct. There is some literature, marginal at least from the point of view of economic growth, covering many aspects of the process of service growth.[35] This literature tends to be based on a stage-by-stage interpretation of economic history, the 'service economy' representing the tertiary stage in the development of modern societies. Moreover, it assumes that the proliferating production and consumption of services is highly dependent on 'social innovations', a term that refers both to restructuring of production, and to the wider social framework (Gershuny and Miles, 1983).

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[34] This chapter draws heavily on two contributions by Dr. Hauknes and Dr. Wood on the role of knowledge-intensive services in the learning economy. Both were written specifically for this project.

[35] Part of this literature can be traced back to prominent writers like Fisher (1935), Clark (1957) and Fuchs (1968).

Another set of recent approaches to services in the 1980s focused on the issue of regional regeneration, particularly 'advanced' or 'high quality' business services as important economic activities for regional growth (Illeris, 1996 and Holmén and Jacobson, 1997). Last but not least, other literature has described the role of key services in industrial organisation, in terms of the role of strategic services in shaping competition and comparative advantages, as in the strategic management literature (Quinn, 1992), and the role of 'technological' services and competencies in shaping new industrial structures and organisational patterns (Reich, 1991).

To a certain extent all these approaches take the view that there is a complementarity between services and manufacturing, which raises the problem of establishing a clear border line between the two, given that *"every high-value enterprise is in the business of providing services [specialised research, engineering and design, sales marketing and consulting, strategic, financial and management] ...(Therefore) the [distinction] ignores the weblike relationships that are shaping the new economy"* (Reich, 1991).

Hence, there is a general shift of emphasis from the perception of services as production and consumption *sectors* towards services as *functions*. This interest reflects the new insights about the role of knowledge production and distribution in the economy, and more specifically, the provision of new knowledge-based services and the reshaping of old ones. Therefore, knowledge intensive services acquire a special relevance within the overall service sector as crucial instruments in the learning economy and in the innovation process.

What are knowledge-intensive services?

Services are a heterogeneous set of activities. Some service firms are small, labour-intensive and use only primitive technologies, while others are capital-intensive, knowledge-intensive and major users of information and communication technologies. Some operate in local environments where there is little competition, while others, such as telecommunication and financial services, have become international and have experienced a radical increase in the intensity of competition. The role of innovation in these different sectors is very different and we need to map more closely what is going on in terms of process and product innovation in the different kinds of services, including publicly procured services, and establish indicators.

As mentioned, knowledge-intensity, in some senses of the word, clearly plays a role in some of these services. But knowledge-intensity is hard to define and still harder to measure. To the extent that knowledge-intensity reflects the integration of output with a generic or specific science and technology base, it can be seen as a combination of knowledge embedded in new equipment, personnel and R&D-intensity.

The difficulty of defining knowledge-intensive services precisely is evident not only at a theoretical and conceptual level, but is also reflected in empirical data recording. In this sense, it is important to mention the lack of a homogeneous and standard classification of this specific sector in European national statistical departments and Eurostat. This situation hinders reliable cross-country comparisons and European-wide studies of the structural dynamics and transformations of knowledge-intensive services. In spite of the increasing importance of the sector in the learning

economy there is very little factual statistical data on services, especially compared with old stagnating sectors like steel and agriculture.[36]

Until there are more developed instruments for identifying knowledge-intensive services, we have to resort to the kind of approach used as a basis for the OECD's high-, medium- and low-tech classification of manufacturing industries, namely simple R&D intensities. Tables 1 and 2 outline the sectoral content of a survey of technology-based knowledge-intensive services (knowledge-intensive services) carried out under the TSER Project SI4S.

Table 1: Technology-based (T) knowledge-intensive services (knowledge-intensive services)

T knowledge-intensive services categories	NACE
Hardware consultancy services	7210
Software consultancy and supply services	7220
Data processing services	7230
Database activities	7240
Maintenance and repair of office	7250
Other computer related activities	7260
R&D on natural sciences and engineering	7310
R and experimental D on social sciences and humanities	7320
Architectural and engineering activities and related technical consultancy	742
Technical testing and analysis	743

Table 2: Potential technology-based knowledge-intensive services (knowledge-intensive services)

[36] One of the first attempts to provide a comparative statistical basis of knowledge-intensive services in Europe was developed in a three-country report about employment trends in the sector (Gaebe and Strambach, 1993).

Potential T knowledge-intensive services categories	NACE
Technology-related publishing	part of 221
Wholesale in machinery, equipment etc.	516
Logistics services and related transport services	632
T-KIBS in telecommunications	part of 6420
Patent bureaux	
Technology-related market research	part of 7413
Technology-related economic and management consultancy services	7414
Labour recruitment and provision of technical personnel	part of 745
Technology-related training	parts of 8042 / 8022 / 8030

These two tables provide an approximative listing of service firms demonstrating knowledge-intensity in various forms.

The innovation process and the role of knowledge intensive services

The service sector plays an important, but diffuse, role in the innovation process. Knowledge-intensive services may not be dominant forces in the overall process of innovation, but they influence and are significant catalysts for wider organisational and technological change, as knowledge-intensive services, and more specially knowledge-intensive business services (KIBS), affect the learning capacity of the system. The search for learning-based resources to respond to the challenges of globalisation appears already to have favoured the recent expansion of commercial knowledge-intensive services. This experience serves to illustrate the important issues raised by innovation-oriented change more generally. Through their function as intermediaries between companies' idiosyncratic, and often tacit, knowledge bases, these services play an increasingly complementary role to more traditional public 'technology transfer' instruments. Similarly, knowledge-intensive services, and more specifically KIBS, are crucial instruments for inducing organisational change in different institutions (not only firms).

But what are the sources of the internal innovativeness of knowledge-intensive services? Research in the TSER projects indicates that these are similar to the ones identified in manufacturing firms and in the industrial sector in general. Those sources include:

- *Personnel and human resource management* - Their ability to recruit specialist ICT, sector-specific and management personnel and employ them across a range of client applications. Their own adaptive learning processes are augmented by a variety of project experience.

They also devote resources to developing distinctive change methodologies and establishing specialist sources of information and intelligence.

- *Proficiency in IT systems* - Global knowledge-intensive services are developing advanced IT systems to support their own activities. They also play a significant role in adapting computer-based management systems to individual client circumstances.

- *Flexible, decentralised organisation* - It has been widely noted that knowledge-intensive services firms are organised in innovative, flexible ways, cutting across the rigidities of formal organisations, employing project-based teams, and incorporating close working links with clients. They depend for success largely on reputation.

- *International and cross-sectorial expertise-building* - One of the most significantly innovative features of modern knowledge-intensive services is the increasingly international scale of their experience and intelligence-gathering. Global and international knowledge-intensive services are thus becoming a distinctive source of new ideas and expertise for many clients, especially those operating at national or regional level.

However, the essential difference between manufacturing and knowledge-intensive services firms is *the type of product* they offer; and through that, their role in the innovation process.

The role of knowledge-intensive services in national and regional innovation systems is closely tied to the 'products' these services supply to the market. Specialised expert knowledge, research and development ability, and problem-solving know-how are the real products of knowledge-intensive services. Given increasing differentiation and the accelerating growth of knowledge and information, indirect effects, like the early recognition of problems and more rapid adjustment to current economic and structural change, can be expected when firms succeed in utilising this external knowledge (Strambach, 1997, p. 35).

Not only does the content of the product have an indirect effect on the innovation system by increasing the adaptability of knowledge-intensive services client firms, but so does the nature of the product itself. The 'intangible' nature of knowledge-intensive services products means that they are used differently from simply purchased external services. The interaction between supplier and customer is far more intense, involving both partners in a process of mutual and cumulative learning where the transfer of knowledge and problem-solving takes place. This is the reason why *"the results of the interaction process depend on the competence of both the knowledge-intensive services supplier and the client"* (Strambach, 1997, p. 35). The role of the demand side then becomes strategic in achieving successful and valuable client-supplier interaction regarding the delivery of knowledge-intensive services products. This relates back to earlier points about *the importance of the advanced demand side* in innovation systems. Thus knowledge-intensive services play a crucial role by stimulating the positive feedback that in the long run can increase the capacity of the demand side to adjust more rapidly and effectively to new innovative and learning contexts.

The transformation of knowledge-intensive services over the last two decades

The knowledge-intensive service sector has been through important changes over the last two decades with the globalisation of the economy, the growing importance of information technology and tacit knowledge, and the process of deregulation and privatisation. The last of these trends has been of special importance in Europe. The macro-economic shifts since the 1970s towards stricter control of public finances and inflation, *the deregulation of many services and utilities*, and the privatisation and outsourcing of publicly-operated functions, have drawn heavily on the expertise of knowledge-intensive services firms. The innovations required by these changes are mainly organisational, often moving from bureaucratic, hierarchical cultures to more devolved and market-oriented methods of operation, supported by new information and computer technology. Such expertise is now an important basis for international knowledge-intensive services activity. Strategies of cost-cutting and, more recently, of efficient service delivery require processes promoted by knowledge-intensive services including financial monitoring, business process reengineering, market targeting and risk assessment.

Given their instrumental role, *the impact of globalisation in knowledge-intensive services enterprises* is an important issue for innovation-oriented change. The evidence from the TSER projects shows that the supply of knowledge-intensive services is highly segmented between relatively dominant multinational agencies and many national and local SMEs. Traditionally knowledge-intensive services have operated mainly at regional or at national scales of exchange, because of the need for close user-producer interactions in information- and expertise-intensive functions. Two developments have transformed these geographically confined patterns over the past twenty years, namely, increasing demand from multinational clients (MNC), and a growing ability to deliver expertise over long distances. The first of these encouraged the international expansion of US- and European-based consultancies offering MNCs consistent standards of service, often through networks of semi-independent partnerships. Subsequently, the growing 'tradability' of knowledge-intensive services has supported the closer integration of their global operations. Some sectors, such as engineering and architectural service firms, were internationally-oriented earlier than others. Recently the most rapid internationalisation has affected management and computer-based service firms.

Many nationally-based specialist service firms are today expanding into foreign markets, especially as these become more integrated, for example in the EU. Often this is achieved by following the international activities and contacts of home-based clients, including MNCs. Like global knowledge-intensive services firms, exchange may be supported through any combination of IT-based information export, short- or long-term mobility of key personnel, or investment in foreign partnerships or branch offices.

An important contribution of knowledge-intensive services to the learning required to respond tc globalisation is their role in *the creation and distribution of both tacit and codified knowledge*. This is a much wider process than that associated simply with new information technology. The primary role of knowledge-intensive services firms' is to review the wide range of technical, managerial and marketing knowledge, through their own research and experience of collaborating with many clients and to adapt and codify it for other clients. It is axiomatic that the innovative methods they promot now will become standard practice in the future, so this codification role is itself broadly innovative The same principle applies to the new information and computer technologies, engineering and othe

technical consultancy and to new management processes. The profits of knowledge-intensive services depend on the active transmission of specialist knowledge and applications experience to clients, and between sectors, regions and nations, so their role in the innovation system is very important in this respect, helping to overcome the limitations of local networks and to diffuse local knowledge world-wide.

Restrictions on intellectual property rights do not significantly affect knowledge-intensive services activities, at least not in their main relationship with clients. This is because knowledge-intensive services are generally not engaged in strictly technical innovations, which require patent law protection, except in those cases where technical service firms support client investment in development. Knowledge is mainly embodied in staff skills and organisational adaptability. Innovative investment is seldom critical and staff mobility to competitors is not a long-term threat. As examined earlier, the uniqueness of the 'product' of each knowledge-intensive services firm arises primarily from the circumstances of each client, and from their capacity to build strong supplier-client partnerships in the search for specific solutions.

Policy implications

The introduction of this report suggested that new and flexible institutions are required to support learning processes in an increasingly globalised economy. Knowledge-intensive services provide a diversity of specialist expertise by a variety of means adapted to the needs of a wide range of private and public sector clients. Therefore, the growth of knowledge-intensive services illustrates this increasing demand for new learning and change within firms and organisations. This is why public action should be more aware of the role played by knowledge-intensive services in the learning economy, and why it should proactively encourage the use of these services as a way of enhancing the organisational and technological transformations of firms.

The growth of knowledge-intensive services raises many important questions about appropriate policy instruments in a context where the private sector can now itself offer commercially informed support. The internationalisation of knowledge-intensive services has strengthened their potential influence even more. Innovation policy must be sensitive to the intensity of competition, the rates of possible innovation arising from research and dissemination processes, and the capacity of firms to absorb and utilise new knowledge through human resource development. All these tasks are now widely supported by knowledge-intensive services firms, sharing mutual learning capabilities between European, national and regional levels of innovation experience. Policy support for the use of knowledge-intensive services requires a process-oriented perspective which fosters interaction between clients and those services. In this sense, this chapter has examined the importance of advanced demand in the innovation system, and the need to encourage the use of these services.

However, there are two major points which should be emphasised. The first concerns the difficulties posed by the 'intangible' nature of the products knowledge-intensive services offer. If the use of these services is to be encouraged an important element is to build trust among potential users. *Quality control* is a crucial mechanism for achieving this. Therefore, public policy could consider the benefits of helping to establish, at national and European levels, collective instruments and institutions for controlling quality within the sector, while respecting fully the strong self-organising

nature of this sector. This could be done without undermining the specificities of each firm's products or profile, and taking into account the intrinsic 'intangibility' of the product.

A second point concerns accessibility of these services. Typically knowledge-intensive services activities are highly concentrated in the most developed regions and the main users are large firms rather than SMEs. Therefore, a major role for governmental action is to *support the use of such services in the less-favoured regions of the EU, and in small and medium-sized enterprises.* Public actions could be taken at different levels, and not only at European and national level. Some limited but highly positive results have already been achieved by pilot projects of the EU programme 'Regional Innovation Strategies' under the Structural Funds, which have promoted networks and partnerships among regional actors for the definition of strategic innovative actions, and actively involving SMEs and specific knowledge-intensive services (Landabaso and Reid, 1997).

Chapter 9: Technology procurement and user-oriented Policies[37]

Introduction

One of the areas where European integration has changed the innovation policy framework most directly is public procurement. Before the single market was established public procurement was mainly a national instrument designed to support the capabilities of domestic firms and used most conspicuously in big science projects and infrastructure building. Today it involves much more European interaction, even if there are still some barriers for foreign firms wishing to participate in national projects.

Procurement is important because it directly and effectively creates demand. R&D support schemes, improvements to technological infrastructure, or encouragement of innovation networks give firms easier access to technology and help increase the knowledge base of the economy. However, the effects of these instruments are uncertain in that their success depends on the ability and readiness of the actors operating in the system to absorb and maximise the potential of these incentives. Developing *demand-side policy instruments* is of equal relevance for European and national systems, and relate to policy actions designed to enhance the technological competencies of the system by emphasising the role of the user. Examples of such instruments include government technology procurement as well as laws, regulations, standards and related institutions, which help shape demand for technological products. Demand policies might be more effective, as they directly stimulate the innovator's activities. When government operates as a customer in a market or when it organises private demand (by supporting users) it directly affects the supply of technological and innovative products.

This chapter will be devoted to two interrelated topics. Firstly, it will address questions relating to the rationale, types and models of government technology procurement. What are the main political and economic arguments for developing such demand-side oriented policy instrument? What is the rationale for state agency involvement in such a task? Should technology procurement be seen as a special element in the overall governmental procurement policy, or as a separate issue? Secondly, the chapter will discuss some important aspects of user-producer relations. In the case of innovation, these interactions generally take the form of vertical interaction between firms, through which products or production processes are (re-)designed. This is what has been defined as technology procurement without (direct) government intervention, and which also works on the demand-side of the innovation process by aggregating and identifying more explicitly new needs on the user side.

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[37] This chapter is based on the contribution of Prof. Charles Edquist and Prof. Leif Hommen (1997): "Government Technology Procurement and Innovation Theory" (TSER Programme paper for discussion at ISE project meeting).

What is Government Technology Procurement?

Government Technology Procurement (GTP) is one of the possible forms of technological-oriented interaction between users and producers, where the user is a government agency. Such interactions are essentially complex, involving the exchange of knowledge and information in a process of collective learning. Therefore, this type of interaction goes beyond the assumptions of neo-classical economists, whereby user-producer relations in the market place occur only in the form of price and quantity signals. Furthermore, GTP is normally conceived not only in terms of the 'market failure' rationale for policy intervention, but also with some defined social and political objectives. In other words, the role of Government Technology Procurement is to articulate demand for specific technological and social purposes.

Government technology procurement

Technology procurement occurs when a government agency places an order for a product or system which does not exist at the time, but which could (probably) be developed within a reasonable period. Additional or new technological development work is required to fulfil the demands of the buyer. In contrast to 'Government Technology Procurement', regular 'Government Procurement' occurs where government authorities buy ready made 'simple' products such as pens and paper – where no R&D is involved. Only price and performance of the (existing) product is taken into account.

Edquist and Hommen (1997)

The rationale for and against government intervention

Government Technology Procurement has explicitly or implicitly been used extensively by most advanced industrialised countries since the war. These policy instruments have been developed in relation to a set of theoretical arguments for and against the economic effects of technology procurement.

Opponents have emphasised the nature of political decisions relating to procurement. Much of the recent public debate on procurement, including - but certainly not limited to - discussion of failures in GTP, has drawn attention to the distorting effects on rational economic decision-making of what may be broadly termed 'political considerations' (Edquist and Hommen, 1997, p. 8). Three of these effects seem to be the most salient political obstacles for efficient economic decisions in this area: firstly, the in-built 'risk avoidance' tendency of decision-makers; secondly, their preference for short-term projects with rapid political pay-offs; and finally, their preference for decisions without major distributional impact (no clear 'net payers' of the actions). These three features of political decision-making are perceived as important barriers to rational economic decisions, especially in the area of governmental procurement.

A second set of arguments against technology procurement policy concerns the way in which state intervention affects the nature of the market. Government buyers, it is argued, tend to maintain the same suppliers for long periods of time, thus creating too close relationships. In such a context

innovation and technology may be blocked for reasons of risk-avoidance because of a comfortable relationship between the government agency and the producer.

There have also been abundant arguments in favour of government technology procurement in the past decades, both the classic market-failure arguments and, more recently, arguments based on system failure. The former include:

- under-investment in socially desirable technologies;
- high risks of early buyers or users of a new technology, preventing the emergence of a market for innovative products;
- under-investment in long-term and/or high-risk R&D; this might be for several reasons, for example, insufficient capacity for undertaking R&D in some industries (fragmentation, small firm size, the large-scale nature of some projects);
- military requirements and/or economic security needs for domestic capability in strategically important technologies or supplies.

Other types of non-market or system failure, such as the ones explored in Chapter 3, are important arguments for this demand-side instrument of innovation policy. We could mention for example, learning failures, where firms are unable to learn effectively or rapidly enough; technological lock-ins, where firms are for different reasons locked into defined technologies of a post-paradigmatic nature; or transition failures, where firms have strong competences only within a specific technological area but have difficulties moving into a related area.

The US and European models

In practice, these arguments are reflected in different forms of government technology procurement. Policies differ according to the national institutional and economic context, and in relation to different policy traditions and approaches to public intervention in general, and innovation policy in particular.

The US has one of the best-known models of government technology procurement policy, developed since the war. Based on the central role played by US defence programmes, Federal Government has awarded important contracts to large and small organisations (mainly firms and university departments) for the development of specific technologically advanced defense items.[38] The model has two particular features. Firstly, contracts have been awarded not only to well-established institutions, but also to new ones (like new high-tech oriented SMEs), and in many cases to firms

[38] For the impact of US procurement on soft-ware see Mowery and Langlois (1996). This is a case we shall make use of in the concluding chapter on policy implications.

interested in developing new products for non-military commercial markets. Secondly, governmental agencies have played an important role in promoting dissemination of the new knowledge to the industrial community. The explicit spin-off aim and the path for commercial exploitation of results have been an unparalleled feature of the US model. Western European policies either do not refer explicitly to technological elements in their procurement policies, or if they do, they develop models under different premises.

This is the case of Sweden and other European countries, where this policy instrument has been used to develop mutually dependent relationships between government agencies and large technologically-oriented firms in strategic sectors. Defence procurement has played a role, but not to the same degree as in the US, given that other government agencies specifically devoted to civilian technology have acted as procurers. A basic difference between the 'European model' and the US one is that the former makes less explicit efforts to force contractors to disseminate research results.

An interesting issue is whether or not government technology procurement is a policy instrument that can be designed in such a way that it *effectively promotes exploration rather than exploitation in the innovation system*. The US experience in the post-war period is an interesting example in this respect. As a result of significant support to military-related research through procurement and through building new knowledge infrastructures, the US played a key role in the promotion and development of a new techno-economic paradigm based on information technology – promoting infrastructure and hardware as well as software. This owed a lot not so much to the demand for very specific products and services by the military, but rather to the investments in university training and research promoted by the military sector. Comparatively, the European national models did not use these broader policy instruments to the same degree, and consequently were not in a position to foster the emergence of new technological paradigms, nor to benefit from the tacit knowledge created in the exploration efforts. What this teaches us is that demand which does not emanate from the market but which relates to wider social needs may be a factor that stimulates the opening up of new technological trajectories at a time when the main tendency is to exploit the existing knowledge base.

The historical differences between the US and European models provide interesting lessons for the present and the future. They indicate that government technology procurement is an interesting instrument because it may be part of a strategy to open up new technological paradigms, it should be more extensively used as a means of enhancing the exploratory side of the innovation process, with specific social goals, like low energy consumption assets and environmental objectives.

Towards a second generation of policy instruments?

Over the last decade there has been a growing awareness among European national policy-makers that procurement is an important instrument for enhancing the technological capabilities of the system. However, there are different national models for defining these policy instruments and different types of government technology procurement. Edquist and Hommen distinguish two main categories:

1. "Procurers as end-users" v "Procurers as catalysts"

The classic government procurement policy, including technology-oriented actions, is based on the role of government as main user. In areas such as defense, or transport and telecommunications infrastructure, the government agency is the buyer and end-user of the product procured.

An alternative role for the procurement agency is to work as intermediary for the end user of the new technological product. In other words, the agency is not the final destination of the procured product (PTT or railway companies), but an agency specifically designed for promoting technologically advanced products for specific technological and social purposes.

One example is the Swedish agency NUTEK, established with the purpose of fostering the creation of more energy-efficient products through the use of new technological knowledge.

"An example of NUTEK activity in energy-saving is the procurement of new refrigerators in the early 1990s. The requirement was that much less freon - which damages the atmosphere's ozone layer - should be used in production and that the refrigerator's energy use should be considerably lower than with earlier designs. A bidding contest was announced where the prize - which was an order of at least 500 refrigerators - went to the company which could best satisfy the demands. A design which could meet the demands was presented by Electrolux within a relatively short time. This example illustrates that innovation policy through technology procurement can have other objectives besides economic ones." (Edquist and Hommen, 1997, p. 17).

Other examples of successful action by NUTEK are shown in the following table:

Project area	**Energy reduction of final product**
Refrigerator/freezer	by 33%
Washers and dryers for communal laundry rooms	by 50%
Ventilation: replacement of fans in a residential area	by 50%
High-frequency ballasts for lighting	by 20%
Windows	by 44%
Heat pumps	by 30%

Source: Westling (1997)

2. "Creation-oriented" and "dissemination-oriented" procurement.

The cases examined so far refer mainly to examples of 'creation-oriented' technology procurement policy, with certain specific technological and social objectives. This means that results from bidding contracts have been innovative on a global scale, producing results that enhance the knowledge-creation process through new findings.

Another type of technology procurement focuses on dissemination, seeking to introduce into the country a product or production process which already exists. It is thus designed specifically to foster the adoption of, and conversion of the national industrial base to, new technological developments taking place elsewhere. 'Dissemination-oriented' procurement includes R&D activities by the producer, focusing on the adaptation of these new products, production processes or knowledge-bases into products designed specifically for the national market. An example of this might be the adaptation of software products for the education system or the health system.

User-producer co-operation: Technology procurement without government

In the private sector, similar cases of technology procurement are a regular phenomenon. In these cases technology procurement takes the form of user-producer co-operation, or vertical networks, resulting in new products or more efficient production processes.

A successful example of this type of relationship was the three-year co-operation venture between Toyota (as customer) and Nippon Steel (as supplier) at the beginning of the 1980s. Both partners identified common interests in developing a new type of corrosion-resistant steel sheet to be manufactured by the latter (Hellman, 1993). Both firms pooled resources in an R&D project for that purpose. Nippon Steel faced major problems at that time and needed to diversify its production through more customisation. Similarly, the interest of Toyota in the project was based on its capacity to influence, through its strong technological capabilities in this area, the characteristics of a product of key importance in the car-making industry.

User-producer co-operation schemes are forms of vertical innovation networks, where partners are firms within the same value-chain production process. In the case of the Toyota-Nippon Steel venture, the agreement established that Nippon Steel would license the patent to other Japanese steel-makers (so Toyota could continue its policy of multiple suppliers). In turn, Toyota accepted 18 months exclusive supply from Nippon Steel. This trade-off was possible in a context of fast-changing technological developments, where Nippon Steel expected to benefit largely from the tacit knowledge acquired during the project, despite the rapid licensing of the patent. The collective effect of this co-operation agreement was the generation of new knowledge and the dissemination of its codified elements through the system.

What are the conditions for the emergence of such successful forms of co-operation between private users and producers? And what should be the role of government technology procurement in this respect?

As mentioned earlier, government technology procurement takes account of the demand-side o innovation policy. This means that the structure of the market, and more precisely, the configuratio

of demand, is also a crucial element in technology procurement in the form of user-producer co-operations. There are three ideal types of market structure: monopsony, polypsony and oligopsony. In each of them user-producer co-operation or technological procurement takes different forms.

Where there is *monopsony*, there is bound to be strong demand-pull and incentives for user-producer co-operation. Yet, monopsony rarely occurs in the strict economic sense, and when it does the buyer tends to be a public agency. This situation tends to encourage rigid supplier-buyer relationships, with substantial risks for discouraging innovative practices. This has been one of the most important arguments behind the deregulation trends in mature industrial sectors in Europe since the mid 1980s (such as telecommunications). However, monopsony in public demand for new technology is still common in large scale projects. The role of government technology procurement under these conditions can be justified in the following circumstances: when a new industry is in the early stages of development and has a high potential for innovation, but a high level of technical risk. This applies, for example, to UK and Norwegian experiences with North Sea oil development.

Alternatively, *oligopsony*, with a small number of large buyers in the market, is ideal for user-producer co-operation. Each government agency is often just another large buyer on the market, and in this respect government technology procurement might focus on the development of socially desirable technological products. In other words, GTP might concentrate more specifically on the social and/or environmental side of new (less exploited) technologies.

Finally, in cases of *polypsony*, where demand is atomised, there is little incentive for user-producer co-operation. GTP then has an important role to play as a catalyst (rather than as end-user) for the promotion of specific lines of technological development. Government intervention can do much to encourage the aggregation and articulation of demand by helping to specify parameters in new technological areas according to socially desirable objectives. The example of NUTEK in efficiently 'empowering users' is evidence of successful government intervention of this kind.

Type of demand	**Definition**	**Effects on user-producer co-operation**
Monopsony	Very concentrated demand with one buyer.	Strong demand-pull and strong incentives for user-producer co-operation.
Polypsony	Fragmented demand: multiple buyers without concentration of buying power.	Co-operation between buyers and suppliers is very unlikely because producers have greater control of the market.
Oligopsony	A number of large buyers, but no one completely controls the market.	Co-operation is a common practice.

The table above summarises the ideal types of demand and their respective effects on technological procurement.

The EU and national technology procurement policies.

The main role of government technology procurement policy is to stimulate technologically sophisticated demand for specific purposes. A general goal of GTP policy is improvement of the technological base of the system. This can have different objectives:

- *Economic objectives*, namely, improvement of the technological base in an area of important technological and industrial potential for the system;

- *Social objectives*, through the definition of underdeveloped socially desirable technological objectives; or

- *Environmental objectives*, as with NUTEK's objective to reduce the energy consumption of electrical items.

Procurement policies may also be an effective instrument in creating innovative networks. By defining tasks that cannot be addressed by existing constellations of firms new combinations may be stimulated to appear.

Despite wide use of general procurement policies, many European governments do not have a specific strategy for technology procurement. This results in the lack of explicit instruments or agencies for this purpose. In such countries, the definition of innovation and technology policy tends to follow traditional supply-side and linear conceptions of public intervention, where the demand-side is systematically underestimated.

A strategy which aims to tackle the complexities and adaptive capacity of the innovation system needs to integrate government technology procurement policy, as a valuable demand-side oriented instrument, and use it in conjunction with the other available instruments. The exploratory capacity of TP and more precisely GTP opens up interesting prospects for the future in two main directions. Firstly, *designing procurement policies to cope with new environmental and social problems may be a way to open up radically new trajectories* in related technological fields (such as biotechnology). And secondly, technology procurement *instruments specifically targeted at information technology to encourage adaptable methods of organisation and learning, might be a useful way of better meeting the needs of slow learners and less developed regions.*

Government technology procurement policy requires public agencies with substantial anticipatory strategic and technological competencies, in order to identify and predict the potential benefits of specifically designed tenders. These characteristics are also needed in the two dimensions of polic

action examined earlier in this chapter, namely, when agencies act as end-users or catalysts, and when they are creation- or dissemination-oriented.

Should the EU play a leading role? How do the new EU procurement regulations affect the role of national agencies operating in this area? And in cases of weakly structured national strategies, what are the chances of establishing more clearly defined instruments?

The current system of EU procurement rules, and their enforcement, was developed in the early 1990s, as a result of both the establishment of a single European market and the need to rationalise and enforce effectively previously existing EU procurement regulations. The objectives were to eliminate artificial barriers to trade, and reduce unnecessary differences in standards. In practical terms, the EU regulation contemplates three possible procedures for tenders, namely, open, restricted and negotiated procedures. Despite the fact that these regulations are designed in general terms for all kinds of public tenders, the third procedure, namely, the negotiated procurement, seems to have been designed for highly innovative development projects. However, this possibility does not mean that the EU has an explicit and consistent strategy or policy to develop technology procurement for innovation purposes.

The procedures for implementing these regulations follow the decentralised pattern of other EU legislation, where Member State governments are in charge of enforcement. This means that the role of the European Court of Justice is to settle litigation when the national jurisdictional process has been exhausted, establishing EU-wide interpretations of EU legislation. This is supposed to result in the gradual adjustment of national regulations and practices, and in a clearer definition of open-ended European legislation in this field.

However, despite these general trends at European level, there is still much room for manoeuvre at the national level, especially in policies on technological procurement. The framework nature of EU legislation in this area does not prevent the definition of national strategies to encourage technologically-oriented procurement in line with the general objectives of national innovation and industrial policies. As mentioned earlier, the existence of these three different forms of tendering procedures leads to some flexibility in enforcement, and it does not necessarily discourage the use of public tenders for the stimulation of sophisticated technological demand with clearly defined socio-economic objectives.

More direct EU action in government technology procurement could have two direct objectives. In the first place, it could *help in coordinating (well- or poorly-conceived) national actions*. Decisive EU action in this direction would have the benefit of avoiding duplication of effort undertaken at national level.[39] Thus the EU could act as an "inter-nation" agency, stimulating national action in unexplored and potential areas, and exchanging information about specific national action for developing possible national co-operation. A second role for EU direct involvement in this area

[39] There are many interesting examples and experiences of inter-state co-operation in the US with government technology procurement instruments for energy-saving objectives (Westling, 1996).

could be to complement action already undertaken under EU innovation policy. EU innovation policy has often been criticised as being too supply-side oriented. The introduction of EU-wide technology procurement tenders with specific goals would certainly stimulate technology development in certain specific areas of technology with large potential for European industry as a whole. Needless to say, the role of a hypothetical EU agency for that purpose should be based on the idea of working as a catalyst, with a strategy combining creation- and dissemination-oriented tenders, and encouraging trans-European co-operation between firms as a prerequisite for obtaining the contract.

Chapter 10: Innovation and competition policy in a new context

Introduction

There is a potential contradiction between innovation policy and competition policy. In the main competition policy tends to regard intervention by governments as negative while innovation policy consists of public attempts to guide the rate and direction of innovation. This general contradiction is also reflected in European institutions and policies. The European integration project, from its very beginning, had competition policy as one of its major commitments (Articles 85 to 94 of the Rome Treaty) while the commitment to science and technology policy was not ratified until 1987 with the Single European Act.

Competition policy – a definition

There are two polar notions of competition policy according to Rosenthal (1992). One is competition policy as it coincides with antitrust policy and its enforcement. The other is that competition policy embraces any law or regulation that promotes or inhibits the free operation of the market mechanism. He goes on to argue that the first definition is too narrow and the second is too broad. In this chapter we will include aspects of regulation, trade and technology policies together with antitrust policy in the definition. Specifically, we shall discuss competition policy as one element in a broader package of policies (including trade policy and currency rate policy) that exert pressure on firms to change.

The major point in this chapter is that the tension and growing interdependence between these two policy fields have become of acute importance in the last decade. The old wisdom that intervention can and should take place when, and only when, government failure is less than market failure no longer encompasses what is really at stake. Recent developments indicate that the changes in the innovation process are at the very core of the transformation of the process of competition, and vice versa that new regimes of competition are crucial for the rate and direction of innovation. This indicates a need for major efforts in the field of socio-economic research as well as for a rethinking of the classical limits between the two fields of policy.

Competition and competition policy in the globalising learning economy

To clarify the relationship between competition and innovation policy we are going to analyse the following questions. What are the implications for innovation and competition policy of globalisation and accelerating change? How should we understand competition in the new context? How should we interpret the fact that competition seems to be intensifying while at the same time inter-firm co-operation is becoming more and more frequent?

This area is complex and characterised by long-lasting and competing theoretical streams of thought. Competition analysis and policy is still strongly rooted in the old structure-conduct-performance paradigm. While the mainstream has moved on toward game theory, evolutionary economics has become a major challenge to the mainstream. It is, of course, not the intention to cover this complex

theoretical field. What follows will focus on a few specific new features related to the innovation process that indicate a need to rethink both the analysis of and the policy framework for competition.

Especially, we shall point to the fact that both the traditional perspectives based in the structure, conduct and performance-paradigm as well as the modern game theory approaches tend to become less relevant. Radical technical change and factors related to eruptive change in demand and regulation regimes imply that the borders around what constitutes a market become diffuse and fluid. Just to define market shares gets extremely difficult in technologically turbulent areas such as telecommunication services. The new form of innovation-based competition with regular eruptions also implies that both the rules of the competitive game and the set of players involved tend to be in a permanent flux – to define useful game theory solutions that capture the dynamics becomes correspondingly difficult.

The Schumpeterian trade-off

A first linkage between competition and innovation we should consider is how the first affects the second. This debate transcends the basic structure-conduct-performance framework as well as the traditional focus on the efficient allocation of resources. In the structure-conduct-performance paradigm, performance is measured in terms of production foregone and values not realised, and not on outcome in terms of industrial change and innovation.

In parallel to this static analysis, there has been an on-going debate on innovation and competition that goes back to the late Schumpeter. While in his early work he emphasised the importance of the individual entrepreneur as innovator, Schumpeter points to the big firms and their R&D laboratories as the major source of innovation in his later contributions (Schumpeter, 1934, and Schumpeter, 1942) . The argument was extended by Galbraith (1967) who maintained that the giant corporations were the ones playing the key role in the development and implementation of new technologies. The debate on how competition affects innovation has never become the dominating one in industrial economics; the main focus of mainstream economics has remained on the static allocation issues. But it is fair to say that it has been given increasing attention over the last few decades (Kamien and Schwartz, 1982, Scherer, 1987 and Geroski, 1993).

There have been quite a number of attempts to test empirically whether there is some truth in the assumption that industrial concentration promotes innovation although most of these have not been able to test directly the connection between the two phenomena. A major problem has, until recently, been the lack of indicators for innovation at the proper level of analysis. Therefore indirect and rather unsatisfactory indicators such as R&D-intensity have been used (Scherer, 1965). The results of the tests have been ambiguous. Most of them show that R&D-intensity grows with size, but only as to a certain level, after which R&D grows in proportion to size. An analysis based on other indicators such as patents and numbers of innovations indicate that R&D is more productive in terms of innovations in the smaller companies than in the bigger ones (OECD, 1996b).

One of the major contributions by evolutionary economists has been to demonstrate that the causality between competition and innovation goes both ways, and today there is growing consensus that it is unsatisfactory to assume a linear causality from, for instance, concentration ratios to innovation performance across industries. There are important differences in technologic

opportunities and appropriability regimes between industries that affect simultaneously structure and performance in terms of innovation. In some sectors technological opportunities are rich, and in these innovations will be frequent and there might be room for many small and new firms. It has also been argued that regimes of weak appropriation favour large-scale producers who can distribute R&D costs over bigger quantities. According to Cohen (1995) a strong appropriability regime may affect innovation activities both negatively and positively.

Summary of the empirical results

- There is no registered R&D in many small firms but to a certain degree this reflects measurement principles rather than reality.
- R&D expenditures grow more or less with size.
- There is some - weak - evidence that the relationship between innovative output and size is degressive.
- The evidence in favour of the thesis that market concentration promotes R&D is weak.
- The evidence in favour of the thesis linking market concentration to innovation output is even weaker.
- Sector- and technology-specific variables such as technological opportunity, appropriability and demand explain much more of the variance than market structure (OECD, 1996a).

One major weakness with the analysis in this field is that the most influential variables now end up as exogenous in the analysis. Appropriability regimes will to a certain degree be dependent on institutional factors and the same is true for technological opportunities (cf. the analysis of innovation systems in Nelson (1993) and Lundvall (1992)). It is only by bringing institutional factors into the core of the analysis that differences in terms of innovation performance can be explained something mainstream industrial economists are reluctant to do because it would reduce the general validity of the theory in models.

Competition and incremental innovation

Another even more serious weakness that dates back to the original formulations by Schumpeter is the exclusive focus on R&D and major technical innovations. Incremental technical innovation based on learning, diffusion of technology and organisational change are certainly more important for the performance of any single national or regional economy than major innovations. And we would argue that it is actually less problematic to treat the intensification of competition as an exogenous factor when it comes to analysing the impact of competition on this kind of transformation. New technologies and globalisation have as a major impact that firms in open economies experience

intensified competition. How firms, systems of firms and whole economies react to this kind of transformation pressure (in terms of innovation and organisational learning) is crucial for economic performance.

Some firms will close down while others will be transformed by the pressure for change. Some will intensify their efforts to introduce new products, processes and new forms of organisation more conducive to technical innovation and learning. To analyse this relationship between the intensity of competition on the one hand and innovation and organisational change on the other, Dahmenian concepts such as 'transformation pressure' and 'development power' may be extremely useful (Dahmén, 1988).

One purpose of analysing national innovation systems is to better understand how national economies react to increased transformation pressure. In the ongoing project on the Danish innovation system, DISKO, a survey on organisational and technical change in Danish firms (Lundvall, 1997a) concluded that:

- in the large majority of Danish firms, respondents reported that the firm had experienced more intense competition over the last couple of years;

- firms which had experienced 'much more intensive competition' differed from the rest in being markedly more innovative in terms of products, processes and forms of organisation (moving toward functional flexibility and learning organisations);

- those firms had become much more demanding in terms of qualifications for their employees than the rest, and especially insisted on the ability to take responsibility, communicate and co-operate.

These results indicate that under the specific circumstances of the Danish economy for the period 1992-95, a general increase in transformation pressure promoted innovation while at the same time reinforcing tendencies toward polarisation in labour markets. It is not certain that these results can be generalised to other economies and apply to other periods however. Even so, they indicate that policies affecting the intensity of competition may actually have a much greater impact on dynamic economic performance than is implied by the Schumpeterian trade-off debate.

Competition and co-operation

Until recently, co-operation between firms, and especially horizontal and lateral co-operation, was either neglected or regarded exclusively as a potential threat to competition and economic efficiency (Teece, 1992)[40]. One major factor which has changed this view, and made inter-firm collaboration in technology development more legitimate has been the actual growth in the frequency of inter-firm

[40] In 1984 the European Commission adopted Regulation No 418/85 (Reg. 418) expanding the favourable antitrust treatment of R&D.

alliances aiming at R&D collaboration (Hagedoorn and Schakenraad, 1992). Another factor has been international comparisons of structure and performance indicating that the co-operative mode characterising inter-firm relationships in Japan has been at least as successful as the more arm length's mode in the Anglo-Saxon countries in promoting innovation and industrial efficiency (Sako, 1990).

A change in attitude to inter-firm co-operation is demonstrated by the fact that the competition laws of the US, Japan and Europe in different ways now explicitly allow for inter-firm co-operation in developing new technology. There are differences between the ways exemptions from anti-trust law are designed but the main direction of change has been to give more leeway for alliances aiming at technological development.

One major issue has been whether alliances should be allowed only in connection with the R&D activity as such or whether permission should be extended to include the marketing and sales of the new product resulting from it. In Europe this has been allowed if the original market share of the partners is small (less than 20%) while any kind of extension of the collaboration to common marketing has to be specifically applied for in the US. There are different assessments as to which of these legal systems to prefer. Those in favour of the European model refer to the fact that innovation increasingly has to involve interaction with users and that therefore it would be inefficient to limit co-operation to the R&D phase (Jacquemin, 1988b, p.128). Those more sceptical emphasise the negative impact from increased market power (Geroski, 1993, p. 68).

Spill-overs, sticky knowledge and inter-firm co-operation

Why allow for alliances when they may weaken competition? The main argument is that they may compensate for knowledge spill-overs weakening the incentives for the individual firms to invest in R&D. This basic argument is reinforced when the scale of the effort is big, the time horizon long and the risks involved substantial. But the main argument is that technological alliances may be a way of avoiding under-investment in efforts to innovate. Often a distinction is made between social benefits and the benefits for the firms joining the alliance. For instance, three major kinds of private benefit are recognised by Jacquemin and Soete (1994, p.66):

- inter-firm alliances represent an efficient mode of transaction and an attractive compromise between strong and permanent commitment (vertical integration) and flexibility (pure market);

- faster innovation and risk-sharing;

- synergies in terms of research information and finance.

It is not obvious why some of these private benefits should not also be seen as socio-economic benefits. In particular the combination of specific competencies is a core element in this kind of alliances and in the absence of an alliance innovation may not take place at all. Let us assume that a specific field of innovation can be entered only if two competing firms both with activities located in Europe combine their specific technological capabilities in developing a new product. There are three different possible results if the alliance is blocked by the authorities:

- one of the firms may try to create the missing capability in-house;

- the two firms might merge into one single organisation;

- the field of innovation will not be entered.

It is reasonable to assume that all these three alternatives would leave the economy as a whole worse off than if the alliance was permitted. Before the new capability has been created non-European competitors may have invaded the new field (since speed in innovation has become the major factor of competitiveness in the learning economy). A merger would not only result in a permanent increase in market concentration, but more importantly might narrow down the room for learning and thereby, in the long term, weaken the innovative capabilities of the firms and the economy as a whole (Lundvall, 1985).

This implies that the emphasis on spill-overs as the major argument for allowing alliances is misleading. In this context it is also important to take into account what many innovation studies have demonstrated: knowledge is neither completely excludable nor the opposite. In order to be able to get access to specific knowledge developed by another firm a lot of in house knowledge building has to take place (Cohen and Leventhal,1990). Neither will spill-overs always result in under-investment. Especially in the context of network technologies spill-overs may actually be a factor stimulating investment in R&D (Langlois and Robertson, 1996). Our conclusion is that there are good reasons for designing a competition policy which allows technological alliances. However, the major reason for doing so is not spill-overs, but rather the opposite – sticky knowledge.

Typically the situation will differ from sector to sector. In sectors such as pharmaceuticals and fine chemicals where knowledge is highly codified and easily transmitted through templates the spill-over argument may play a more important role, while stickyness may be the main argument in the majority of sectors where core competencies remain in the form of non-codified know-how. It may also differ between countries. In Japanese firms strategic elements of knowledge remain tacit to a much higher degree than in Anglo-Saxon firms (Lam, 1997).

This brings us to some general considerations on competition analysis and policy in relation to innovation. Competition policy will always aim to establish some general principles that can be applied indiscriminately to all sectors. This approach is recommendable because it leaves less room for sectoral vested interests to come up with ad hoc arguments in favour of their own case. But it is a problem when it comes to handling issues relating to industrial dynamics and innovation. The basic mechanisms behind innovation and competition are radically different between sectors like the mechanical engineering, pharmaceuticals and steel industries (Pavitt, 1984). As the role of the independent authorities regulating competition policy is growing at the national and European level the need for them to have access to the necessary expertise and to understand such difference becomes more important.

Globalisation, regionalisation and technological alliances

It can be shown that the frequency of international technological alliances has been growing especially in high technology fields the last decades. This is true for both intra-regional and inter-regional alliances between the 'regions' of the European Union, Japan and the US. Data for the 1980s, indicate that intra-regional alliances tend to grow more rapidly than inter-regional ones (thus indicating that globalisation is taking the peculiar form of growing regional integration). The data show that European firms tend mainly to join alliances either with each other (40%) or with US firms (50%) – the number of alliances with Japanese firms remains rather small (10% of all registered alliances involving European firms - Buiges and Jacquemin - 1996).

The growing frequency of alliances relates to global competition in two ways. First, it points to the risk for global oligopolies and second to the need for moving towards a world-wide competition policy (Jacquemin and Soete, 1994 and Jacquemin, 1988a)

Competition, market structure and product innovation - the software case

E.G. Richardson recently made some crucial contributions to the understanding of competition in technologically dynamic sectors with frequent introduction of new products (Richardson, 1996, and Richardson, 1997). In Richardson 1997, the focus is on the software sector where marginal costs of use are close to zero while development costs for new generations of software are substantial. This is thus a sector where innovators may capture big market shares, at least as long as their intellectual property rights are protected. Seen in static terms at a given moment this may seem as tantamount to a monopoly-like situation. Regarded in an inter-temporal and dynamic perspective it becomes clear that the potential and real threat of new products implies a situation of intense competition.

This points to a concept of competition where the innovative effort necessary to defend the position of a firm should be taken into account as an indicator of the degree of competition. In sectors where little innovation is combined with high rates of return there is obviously a lack of competition, while sectors earning a high rate of profit on a single product may earn only normal profits when development costs over a longer period are taken into account: competition is not perfect in the traditional sense but it is certainly intense.

It has been argued that more and more sectors are characterised by the formation of new market forms substituting for national oligopolies. The scope of the market is global rather than national and can be characterised as 'knowledge-based networked oligopolies' (Mytelka and Delapierre, 1997). Second, it may be regarded as a response to more intense technological competition and the alliances as a factor that further increases the speed of the innovation race (Davis, 1997). As a matter of fact,

both aspects are pertinent. In some sectors such as automobiles the main impact of alliances may be to reduce competition while in others, such as computers, alliances may have as their primary impact a further acceleration of innovation (Mytelka and Delapierre, 1997). Even within the same sector, changes in technological opportunities and in the dynamics of demand will from time to time give rise to new patterns of competition and, as time passes, there will be a need for changes in the regulatory system.

Competition and co-operation in the learning economy

It is an important step forward that competition analysis and competition policy have begun to take into account the positive aspects of inter-firm co-operation in the context of innovation. Still, there might be some way to go before the radicality of the actual changes in the mix of competition and co-operation have been fully taken into account. As referred to in an earlier chapter, Bob Anderson (director of Rank Xerox Research Centre in Cambridge) has recently given an extremely interesting account of competition in a high-tech sector, and describes what is going on as a "Bazaar economy" (Anderson, 1997).

He argues that the most important change in the new context is not so much the increasing role of knowledge in competitiveness as the extreme acceleration of the innovation process. This means that the definition of competitors and collaborators becomes fluid and a major part of the game is to transform competitors into 'co-opetitors'. Actors are constantly shifting roles in these respects, and alliances remain unstable and change over time. Both the rules of the games played and the players involved are in a constant state of flux. Similar ideas are developed by Richardson (1997) and D'Aveni (1994).

The Danish survey referred to above also shows that there is a strong connection between competition and co-operation in a different dimension. Firms that report a strong increase in the intensity of competition differ from the rest in having, more extensively, strengthened their relationships with customers and suppliers (Lundvall, 1997a). This confirms that the growing intensity of network relationships is an integral element of the new regime of accelerating change and intensified competition.

The Internet, which may be the single most important infrastructural innovation since the railways (hailed by Schumpeter as the most important innovation of its day), carries the new mode of innovation one step further. It helps to speed up the innovation process, it makes it even more dependent on an interactive and collective effort involving even distant actors in innovation networking. It breaks down the traditional division of labour between users and producers of innovation, once again with potentially far-reaching implications for competition policy (Fransman 1997).

In certain high-tech areas the establishment of international production networks has become fundamental means of obtaining competitive strength, and the revival of the competitiveness of U firms has been ascribed to their ability to position themselves in networks involving firms in the Asia dynamic economies. Again a key element in the complex networks established is 'speed' both terms of innovation and in terms of expropriating the benefits from innovation. Focusing on co competencies and on the ability to coordinate complex activities in time and space has become a ne

way of creating speedy innovation and adaptation (Borrus and Zysman, 1997). Ernst (1997) shows not only that the globalisation of the sector producing hard-disk drives actually increases market concentration in terms of global market shares, but also that concentration does not reduce rivalry in the sector, since in fact it becomes even more intense than before.

Positioning European firms in global networking

Another policy implication of the high frequency of inter-regional alliances and of direct foreign investment is that it becomes increasingly difficult to ensure that European technology policy favours European firms to the exclusion of, for instance, US firms (Jacquemin and Soete, 1994). In the US there has been a lively debate on the possibility of preventing foreign firms from gaining access to strategic elements of its knowledge base, including academic research, while access to the Japanese knowledge base has been restricted mainly through institutional mechanisms and cultural barriers (Ostry, 1996).

It is doubtful whether a strategy of exclusion and 'Europeanisation' of networking is a good idea. As pointed out in the last section, the construction of international production networks spanning several continents has been a key element in the revival of the US high-technology industries. European firms may actually have been too set on building intra-European alliances and not sufficiently concerned with establishing knowledge-intensive networks with Asian firms, for instance. ESPRIT and European framework programmes may actually have reinforced this tendency.

There are also issues about regional development involved here. Fierce competition between knowledge-intensive networks leads to a situation where some countries and regions end up being well connected to the most dynamic networks while others remain excluded. This is a problem not only for developing countries but also for countries and regions within the European Union where there are signs of growing divergence between regions because of differentiated access to the knowledge base (Fagerberg and Verspagen, 1996). Here the building of regional knowledge-intensive networks, and connecting them to international networks should be a major part of regional development strategy.

Competition policy must be adapted to the new conditions where inter-firm co-operation and alliances have become key elements in promoting innovation and where global market structures increasingly determine dynamic performance. European competition policy has to take into account the need to position European firms in global networks, while at the same time promoting the creation of a stronger and more workable competition policy regime at global level.

Can competition become too intense?

Parallel developments in regulatory systems, technology and trade have, in combination, created a new kind of 'hyper-competition' (D'Aveni, 1994). There is a circular causality between innovation and competition. On the one hand, hyper-competition reflects accelerated innovation, and on the other, it is driving change and especially technical innovation in terms of both its rate and direction. Therefore there is a need to fine-tune policies driving change and to coordinate them with policies aimed at promoting change and coping with the negative consequences of change.

Deregulation and innovation – the case of telecommunication

One way to increase the transformation pressure on firms in a specific sector is to deregulate it. The sector where this kind of competition policy has been most explicitly linked to technological innovation is telecommunication, where national monopolies have been weakened or dismantled by deregulation. This is also an area where technological innovation has played a major role in undermining the old regulatory system. Some deregulation has focused on prices and rates, but another consideration has been the enormous potential for new services that will be realised only in a climate of competition. The case of telecommunication has wide implications for the understanding of competition and innovation.

It is important to recognise that telecommunications is only one of several forms of advanced communications (Miles, 1996). Internet, mobile communications, local networks and television are other media that expand very rapidly. Firms from several sectors where there are major high-tech producers are currently entering this field. Computer companies and television companies are trying to enter, as well as companies connected to the expansion of the Internet. When it comes to building the complementary competencies needed to remain competitive, inter-firm co-operation is the most efficient mode of governance (Colombo and Garrone, 1997). This is interesting because it illustrates in an extreme form how the borders of (and barriers around) a specific market and sector break down as the technological foundation changes.

In such a context it becomes less meaningful to operate with indicators of market concentration (which will typically be a couple of years old) to determine the intensity of competition. Even monopolies will lose market share to intruders if they do not make major efforts to innovate and develop new services attractive to consumers. The last decade has seen an increasing number of sectors reach a situation similar to the one of the telecommunications industry and there will be more of the same in the future. Some of the sectors which have only just begun to feel the growing pressure of competition from a combination of the three factors, technology, globalisation and deregulation, are in services (banking, insurance, business services, law, trade and distribution, etc.). And these are all sectors that account for a high proportion of employment.

Together, the previous observations point to a situation where the problem is not so much t intensify, further, competition in sectors already exposed to international competition and t

accelerate, still more, the rate of innovation in these sectors, but rather the opposite. The very rapidity of change may lead to a misallocation of resources in the sense that too little resources are used to pursue long-term objectives and the production of generic knowledge, while too much is used to speed up movement along known trajectories. This tendency to focus on short term rather than long-term dynamics is reinforced by the increasingly dominant position of finance capital in the governance of firms and by the financial crises of public sectors (Chesnais and Serfati, 1997).

This does not rule out the need for further deregulation and reregulation at the European level. Seen from an analytical view-point it is not at all clear why the Community Agricultural Policy should remain as protectionist as it is. The impact of protectionism on product quality, environment and the quality of life in society shows that the present approach cannot be justified from the point of view of general efficiency. There are many other areas where privileged service providers (such as doctors and lawyers) operate in a sheltered and over-regulated context. But, in the context of hyper-competition, such initiatives may have to be designed in such a way that they take into account the ability to absorb change in the economy as a whole.

Secondly, and this is a major problem given the present mode of development, the very speed of change is a key factor in explaining the polarisation in labour markets and social exclusion. In the TSER projects on globalisation and employment coordinated by Bart Verspagen and the Systems of Innovation project coordinated by Edquist, trade with low-income countries and technology have been identified as two factors contributing to the polarisation evident on labour markets (see for instance Verspagen, 1997 and Edquist, Hommen and McKelvey, 1997). The point here is that these two factors combine with each other and with changes in regulatory systems to intensify competition and speed up change. The outcome is that slow learners will not be able to command a reasonable wage.

Another consequence to be considered is that this speeding-up process may in certain specific areas become a threat to the environment. It is symbolic that traffic jams in the most technologically dynamic area of the world, Silicon Valley, and other environmental factors caused major relocations of information technology producers to other regions in the US which were more attractive in these respects. The recent serious warnings about environmental stress in the newly industrialised economies in Asia also indicate the environmental costs of accelerated change.

Should competition policy aim to slow down the rate of change?

It is not obvious how the rate of change could be slowed down by any kind of local or national policy. If citizens in Europe decided that they were willing to pay the price in terms of a lower standard of living a regional slow-down might be possible but even then a slow-down strategy may prove untenable in the longer run. To run slower than the rest seems to be self-defeating in the sense that running a little slower may ultimately mean moving backwards.

The most obvious solution would therefore be to go for world-wide agreements, but it is difficult to see how such agreements could be reached in a context where competitiveness is the basic goal of all the players. There have been some interesting proposals that might be relevant in this context, even if they focus only indirectly on the acceleration of change and on hyper-competition. One is the Tobin tax designed to slow down somewhat speculation and flux in financial markets. The other one is the

bit tax proposed by Luc Soete and others. The strength of both these proposals is that they are general rather than specific, which means in principle that they can be implemented and controlled. A global sales tax on all exports and imports of commodities and services where revenue went to creating development potential in weak countries and regions would be another general instrument with similar impact.

Another approach is to devise policies to make producers and consumers pay for the full costs of change. We already have the example of the "polluter pays" principle and here the main problem might be to make sure that the principle is actually implemented at a global scale with a fair distribution of the burden between poor and rich countries. Both the environmental issue and the abuse of people for production purposes – child labour, and degrading working conditions – have been on the agenda in connection with trade negotiations. The difficulty here is both to agree on standards between economies at very different levels of development and to find ways of implementing them. The strength of regulations that focus on financial matters – e.g. in connection with the EMU – is that it is less difficult to cheat since monetary value is a one-dimensional variable. To measure what is happening in nature and with people is much more complex, and there is far more scope for manipulating data.

Increasing the capability to absorb change

The obvious alternative to slowing down change is to improve the potential for bringing about rapid change (innovation policy) and absorbing change (regional policy and human resource policy). The rest of this report, and most of the TSER projects covered by this report, are about this alternative. The point made here is that 'hyper-competition' may impose too high a cost if left to its own devices and fueled by aggressive competition policy at European and global level.

A more specific version of this alternative is to focus on the very problems created by accelerating change and to redirect the forces of change towards the solution of these problems. If learning and innovation capability were massively oriented towards solving the problems of underdevelopment and inequality, and environmental problems, the effort to move rapidly ahead might increase rather than decrease the sustainability of the globalising learning economy.

Such a strategy might also be a response to the problem of short-termism and the need to stimulate exploration rather than exploitation. Massive collective efforts in these areas should be temporary and play a role mainly in the initial formation of new paradigms. They might, if properly designed play a role corresponding to the one played by US military demand for information technology and software in the decades immediately after the war. The emphasis could be on creating competent demand and on building new knowledge infrastructures, but leaving strategic decisions about the choice of standards and technologies to the private sector.

Here, it is important that competition policy at European and global level (WTO) should not become a barrier to such a problem-oriented policy, for instance by too strictly interpreting what governments can do without impeding fair competition. On the contrary, competition policy should play a positive role by changing the regulatory framework so that it promotes this kind of strategy.

The division of policy responsibilities between regional, national and European level

The establishment of the European Union has played a major role in developing a new competition context for firms operating in Europe. This involves a whole set of policy instruments, of which some represent transfers of classical elements of domestic competition policy to the European level while others relate more to trade policy, such as the Cassis de Dijon judgment of 1979 when the European Court of Justice decided that Member States have to admit goods lawfully sold in other countries. The establishment of the EMU will confirm a transfer of responsibility to a supra-national level for a whole package of policies that affect the pressure of competition on firms in all parts of Europe. In a historical perspective the movement may be seen as the continuation of a trend already evident in the major member countries towards more market- and competition-friendly regulation, where competition policy is increasingly pursued by authorities outside the direct control of parliaments and governments (Dumez and Jeunemaitre, 1996).

It is important to note that policies designed to cope with rapid change are to a high degree national and regional, while all the policies – including competition policy – affecting the pressure for change have increasingly become the responsibility of the European authorities. To this should be added that these policies tend to be pursued by authorities that are semi-independent from the Council of Ministers and the European Parliament. In competition policy the European Court of Justice takes strategic decisions. The EMU is built around the construction of a semi-autonomous European Bank. This constellation increases the risk of a lack of coordination between policies affecting the pressure for change and policies designed to contribute to change and to cover the social and environmental costs of change.

Summary

There has been a growing acceptance of innovation as a performance variable in conjunction with competition and, in this context, inter-firm alliances aimed at developing new technology have been recognised as potentially beneficial for innovation. But the perspective remains narrow in different respects. Too much of the analysis is focused on major innovations and too little on incremental technical and organisational change. In most sectors the spill-over argument for allowing alliances should be replaced by its opposite; the stickiness of knowledge. In this and in other respects there is a need to be more specific in relation to the characteristics of the sectors involved.

But the most important issue is that competition has become extremely fierce – and that borders between markets and between competitors and collaborators are disappearing - in most areas which are exposed to new developments in international trade and deregulation and that these trends are likely to continue. Therefore a broader definition of competition policy is needed which also encompasses the positioning of European firms in global knowledge-intensive networks and the access of less advanced players to such networks.

And, most important of all, a major problem in the world economy is that the intense competition and the acceleration of innovation in different ways may now threaten the sustainability of the learning economy. Social exclusion, environmental problems and shallow knowledge-production may be the results if current developments are left unhampered or even uncritically supported by policy. A

'no regret' response to this challenge is to reinforce efforts to develop human resources in the form of life-long learning. Special emphasis should be given to the weaker regions and workers and to helping them to enhance their learning capabilities. These initiatives need to be complemented with a global European strategy aimed at positioning European firms in world-wide production networks and supporting the developmental potential of poorer countries. A major threat to the sustainability of the world economy is the massive population flows that might result from a combination of wider income gaps and shorter distance world-wide.

This chapter has tried to identify new trends in the economy where research is still in its early stages. Some of the reasoning in this chapter is hypothetical and based on preliminary studies that call for more analysis. The issues are, however, closely related to the content of the TSER programme of research. They go across the TSER research agenda that combines technology and innovation with issues related to social polarisation and human resource development.

PART III: Concluding Remarks

Chapter 11: Concluding remarks

Introduction

The general purpose of this exercise is to communicate results from on-going research in the TSER programme to policy-makers in charge of innovation policy. It is important to note that what is presented in the report is not just a passive summing up of results from the seven projects covered – which should not be done until the projects are finalised. The process of producing the report has been an interactive one, with the authors playing an active role in presenting a 'vision' to the project leaders and to other experts on several occasions. The results from the seven projects have been crucial building blocks for the overall vision and they have helped flesh it out. Still, some of the policy areas covered in the report (such as "organisation of the firm" and "competition policy") were only marginally covered by the TSER projects and they have been included because they are essential elements in a coherent vision. They also signal important priorities for future TSER research.

The procedure followed reflects our conviction that innovation policy should be given a clearer direction and that the role of innovation policy in the broader strategies of economic policy should be better understood. As can be seen from part two of this report, innovation is an extremely complex process affected by specific sectoral and social characteristics, so it is difficult to present simple models of general validity and to end up with rule-of-thumb policy recommendations. In this respect, innovation policy may be contrasted, for instance, with monetary policy, which is based on much simpler models and also on a simple (too simplistic we would say) vision of the world. To a certain degree this difference reflects real differences between the world of technology and the world of finance. But it is also true that innovation policy is hampered by the lack of simple rules to follow. In the present situation, where everything points to the need for a much more active innovation policy, and for closer coordination of innovation policy with other policy areas, this lack of clarity is, of course, especially problematic.

Our response to this challenge has been to present a simplified vision of the world which, we believe, most experts in the field, including people directly involved in organising innovation activities, will recognise. The vision is analytically based since it is compatible with results from the on-going research in the TSER projects covered in this pilot action but it is still a 'model' of the world since it includes generalisations not all well established by systematic research. These 'missing links' may be used to give direction to the development of future research programmes in the TSER programme or other socio-economic research activities.

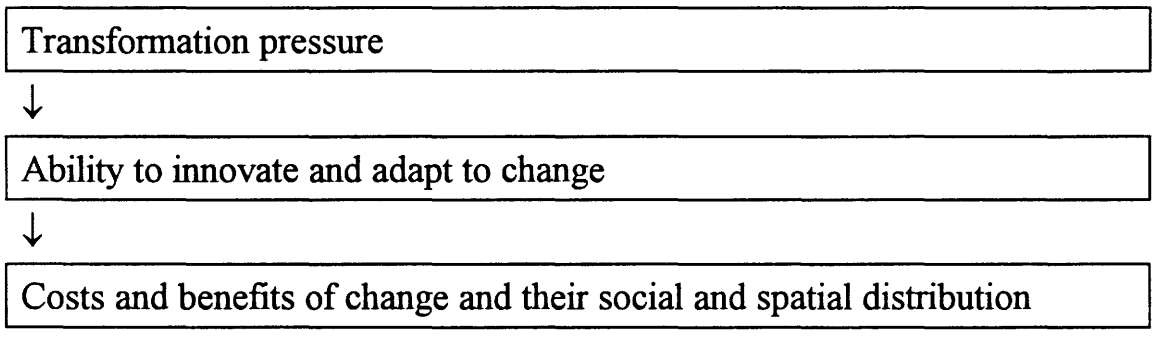
In this last chapter, we shall take the process of simplification and generalisation one step further. The results of the whole report will be presented in schematic form and an attempt will be made to bring out the essence of the report as succinctly as possible. First, we shall present the basic model of causality lying behind the analysis. Secondly, we shall present the most pertinent changes in the parameters of the model linked to 'the globalising learning economy'. A broad set of policy instruments will then be linked to the model and the policy instruments specifically intended to affect innovation will be discussed in relation to the model and to different levels of government. Finally,

we shall present two complementary policy strategies that might be regarded as logical outcomes of the model: a narrower one aimed at speeding up innovation and a broader one explicitly taking into account the costs of change and the sustainability of the learning economy. At the very end of the chapter we shall present some reflections on the need for further socio-economic research.

The model

The basic model underlying the structure of the report is shown in Diagram 10.1.

Diagram 10.1. The basic model



This basic model may be further specified by identifying some of the strategic variables at each level.

Transformation pressure

One of the most fundamental factors affecting the transformation pressure is *technical change*. New technological opportunities in the form of new products and new processes directly affect us all. A second major factor is the *competition regime*. New entrants into markets and extensions of markets bringing in new competitors located elsewhere are factors that increase the transformation pressure. *Governance regimes* – the role of ownership and finance in managing the firms – affect the intensity but also the direction of the transformation pressure. Finally the *macroeconomic stance* affects transformation pressure. For instance a situation characterised by deflationary policies and an over-evaluated currency rate implies strong transformation pressure, as do aggressive trade union wage policies.

Ability to innovate and adapt to change

A key to successful innovation is to have a *strong knowledge base* including an R&D capacity and a well-trained labour force. But as indicated by the concept 'innovation system' many different agents organisations, institutions and policies combine to determine the ability to innovate. Adaptation t change can take many forms and this is the subject of on-going debates on economic policy. *Flexibl labour markets* may be at the core of adaptation in some innovation systems while others adapt mo through *functional flexibility* within organisations. *The creation of new firms* may be a key

adaptability and innovation in some systems while others rely more on *innovating and reorienting the activities of existing firms.*

Costs and benefits of change and their social and spatial distribution

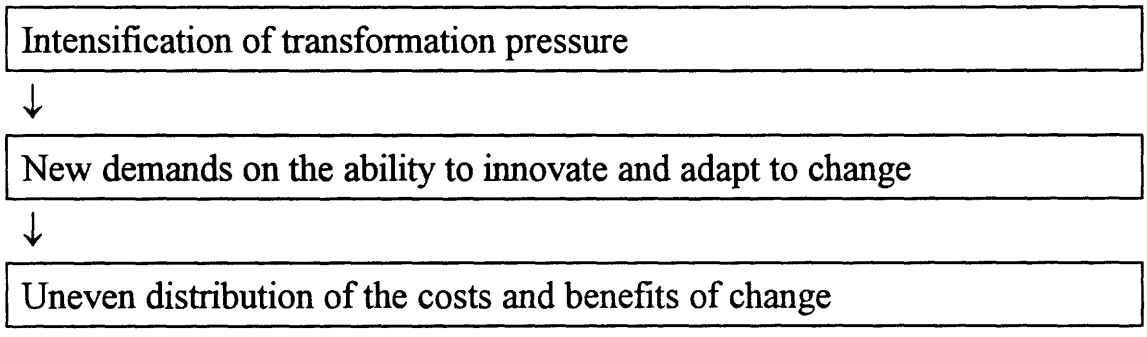
The different forms of adaptability characterising an innovation system will distribute the costs and benefits differently. In a system based on flexible labour markets the *primary costs* will be born by marginal workers while the costs will be shared between employers and employees in systems where firms assume long-term responsibility for their employees. Governments may compensate marginal workers through social policies and through labour market policies so that the actual costs born by marginal workers are reduced and shared by the community.

The *spatial* distribution of costs and benefits will reflect regional and national abilities to innovate and to adapt to change. The nature of the transformation pressure may favour the particular institutional set-ups prevalent in some innovation systems and inhibit others. What might be an ideal set-up in one period may not be so in the next, and it usually takes decades rather than years to fundamentally reorient regional and national systems of innovation.

The globalising learning economy

In this report we have pointed to changes at all the three levels of the basic model presented above.

Diagram 10.2. Major trends in the globalising learning economy



We have shown how fiercer competition and accelerating change give rise to stronger transformation pressure. We have pointed out the need for greater ability to innovate especially when it comes to building new relationships within and between organisations. Finally we have pointed to trends in labour markets and in regional development indicating a more uneven distribution of the costs and benefits of change. Now we will briefly look at the major factors involved at each of these three levels.

Building up transformation pressure

The development and widespread use of new technologies and especially of information and communication technologies has transformed fundamental aspects of the economy such as time and space. It has brought new players into the world trade game, especially from Asia, speeded up long-distance information exchange as well as innovation processes and opened the way for radical transformations of all economic (and social) activities.

The wider set of competitors in world trade also reflects deregulation of trade and international financial flows as well as transport technologies that make it less and less expensive to move commodities and people over long distances.

The collapse of the Soviet system and the inflationary crisis of the seventies have changed the vision of general economic policy, giving greater emphasis to the role of market regulation and less to government interventions that reduce market competition. Privatisation and deregulation increase the transformation pressure on parts of the economy that have so far been sheltered.

These are the main factors which increase transformation pressure. An important point in our argument is that certain mechanisms in the system reinforce this tendency by introducing circular causality. Selection mechanisms in product and labour markets favour change-oriented organisations and individuals and thus increase the transformation pressure.

It is difficult to see what endogenous mechanisms might halt this tendency. The full impact of information technology has yet to be felt: new entrants into world trade are on their way and deregulation still awaits most countries and international organisations. The main limits to the process might be 'exogenous' and have to do with increasing costs in terms of potential social and environmental crises that might trigger popular resistance. The attention increasingly being given to ethical, environmental and social strategies in big firms reflects a growing anxiety about such developments and an insight that, in the absence of both external regulation and self-restraint, the pressure for change might become too strong.

New demands on the ability to innovate and adapt to change

In this area, the TSER projects point to a new mode of knowledge-production and to the need to rethink most of the institutions and organisations that constitute the knowledge infrastructure. The new context puts a premium on interactivity within and between firms, and between firms and the knowledge infrastructure. These changes are reflected in new and more stringent demands regarding the qualifications of employees and management. The ability to combine abstract reasoning with social skills in communication and co-operation, including inter-disciplinary co-operation, is now more important than before. The delegation of responsibility to employees reflects the fact that rapid learning can take place only in a democratic working environment. Services, and especially knowledge intensive services, tend to become much more important, both in their own right and for overall industrial dynamics.

These changes relate both to innovative and to adaptive capabilities. The characteristics of the innovative firm are similar to those of the functionally flexible firm. The kind of external network relationships most conducive to innovation are also similar to those which favour flexible response.

More uneven social and spatial distribution of the costs and benefits of change

The most immediate benefit to consumers is growing productivity, lower prices and a higher level of consumption. Another primary benefit is that members of innovative and flexible organisations may earn a premium or at least avoid bankruptcy. In newly industrialised areas there may be dramatic increases in per capita consumption.

Figures seem to indicate that, on balance, distribution of benefits has become more uneven during the last decade, at least within the OECD area. Profit shares seem to have grown at the cost of wage shares in all parts of OECD since the middle of the seventies (OECD, 1994b, p. 22). Earning differentials between skilled and unskilled workers have grown in the Anglo-Saxon countries and differences in employment opportunities between more or less skilled labour categories have increased in those as well as in the other European countries (op.cit. p. 22-23). TSER research demonstrates that the differences in income between rich and poor regions in Europe remained substantial through the eighties (Fagerberg, Verspagen and Caniëls, 1997).

The nature of the costs of change are quite different for those leading the field and for those lagging behind. This is true for people as well as regions. People who are frontrunners may experience stress, a shortage of time and work overload while laggards may experience exclusion from the core of the economy and be relegated to passive consumption of mass-produced entertainment. From a social point of view the extreme demands on the learning capability of the workforce made by rapid change and intensive competition is costly in that fewer people participate actively in the labour market.

The flourishing regions, taking Silicon Valley as the prototype, will experience congestion, environmental problems, rocketing real estate prices and labour market bottlenecks. The laggard regions will be characterised by poverty, unemployment and other typical underdevelopment characteristics. What is new in this context is that the accelerating pace of change makes access to communication infrastructures even more important, and investment in local knowledge infrastructures has an even more vital role in breaking the vicious circles of underdevelopment.

Another set of costs arising from rapid change and which now need to be tackled are those relating to global and local environmental problems: new industrialisation and the intensification of transport increasingly threaten the basic conditions for human life.

Policy alternatives

Three kinds of policy considerations follow from this basic model. The first has to do with striking a balance between the three levels in the model and coordinating innovation policy in broader strategies. The second has to do with increasing our ability to exploit the potential for change through innovation policy. The third points to a different mode of innovation policy that takes into

account the full consequences of the analysis presented above, including the costs of change and the risk of technological lock-in.

Creating a balance between transformation pressure, innovative capability and distributional objectives

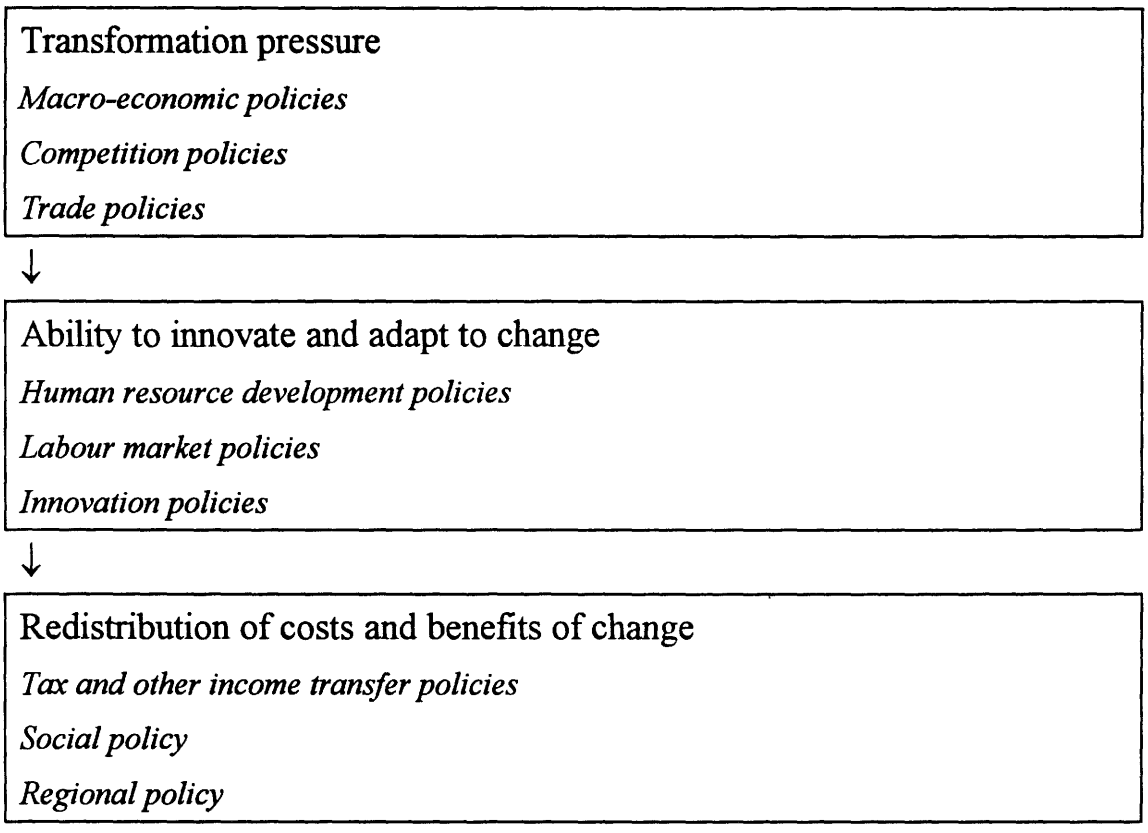
There are packages of policies that affect each of the three levels and this can be illustrated as in Diagram 10.3. (below). A major problem is the tendency to disregard the interaction between policies operating at the different levels. Deregulation policy may, for instance, aim at reducing protectionism for a particular sector and have as its main result an increase in the pool of unemployed unskilled labour: yet, at the same time, government, through its labour market policies, may try to create low-productivity protected jobs through wage subsidies. Without co-ordination different policies might undermine each other's effectiveness.

It is obvious that the costs and benefits arising from increasing pressure for change will reflect our ability to innovate and adapt. We have argued that transformation pressure may become too strong, resulting in social polarisation and social exclusion. Policy initiatives on human resource development and innovation may reduce the problem if properly designed. Redistribution policies may compensate losers. But in all cases the policy package aimed at affecting the pressure for change should be designed in such a way as to take into account our ability to innovate as well as the scope for redistribution.

This problem is especially serious since such packages are distributed unevenly between the regional, national and European levels. One of the major impacts of EMU is that it ensures that the first policy package moves from the national to the European level. Despite the need for better coordination, implementation of this policy package is increasingly left to semi-autonomous institutions not subject to direct democratic control (the courts for competition policy and central banks for monetary policy). The other two packages remain largely the responsibility of national and regional governments. There are European initiatives in the field of innovation policy and human resource development, while the regional funds aim at tackling social and regional distributional issues, but in both cases the resources involved are small when compared to national resources. (The exception, the Common Agricultural Policy, goes to the other extreme, in protecting the socio-economic interests of a specific social group with little reference to any socio-economic rationale.)

A major issue is whether this division of labour is sustainable, even in the medium term. As the pressure for change builds, and currently European-wide policies tend to increase rather than decrease it, the social costs may grow and popular resistance to the whole project might become so strong that the EU would either have to reduce the pressure or become much more active in the other two policy areas. The first alternative would probably involve negotiations to reach worldwide agreement on social (and environmental) standards. The other side of the coin is that intensified global competition and the increasing difficulty of levying taxes in the new Internet trading regime might tempt national governments and regional authorities to compete by reducing social and environmental protection or enter into global tournaments where subsidies are used to attract foreign capital.

Diagram 10.3. Policy packages affecting the pressure for change, the ability to change and the consequences of change



Increasing the ability to innovate – moving along the technological trajectory

In Chapters 5-9 we outlined new principles for a policy aimed at keeping abreast in the innovation race. The most basic principle is to create a learning economy that can cope with rapid change and be successful in developing new products and services. This involves policies aimed at human resource development, creating new forms of organisation, building innovative networks, redirecting innovation policy towards service sectors and involving universities in the innovation process.

Human resource development

There is a growing consensus among scholars and policy-makers on the need for radical change in policies aimed at human resource development. The problem is the huge gap between the official rhetoric and what is actually taking place. While everyone agrees that what we really need is a school system which increases the ability to acquire both theoretical knowledge and social skills, the education system does not change very much. Financial pressures on governments trying to qualify for EMU result in resource scarcity that makes experimentation and radical reform difficult. Business leaders, scholars and policy-makers also agree on the need for life-long learning, and on the need for new teaching methods better suited to slow learners, but there are few incentives to actually do

something. Here, the EU could try to establish an approach similar to the one adopted for financial issues. The most fundamental need is not to standardise curricula internationally but rather to establish flexible norms and standards making sure that sufficient resources are allocated to education and that the activities are designed so that they respond to the new context. It is almost tautological to point out that the economic future of Europe will reflect, above all, the learning ability of its citizens. Paradoxically, it is much easier to reach agreement at European level on subsidising agriculture than it is to agree on the necessary means to realise a community-wide human resource development plan.

New forms of organisation

An organisational revolution is now taking place and European firms have enormous unexploited potential in this respect. The full benefits of information technology can be reaped only if new organisational forms develop. New forms of organisation that increase interconnection and interaction between departments are the key to accelerating innovation. Forms of organisation will always reflect national characteristics and the broader social and institutional context, including industrial relations, education systems and industrial structures. Nevertheless, new broadly-defined better-practice organisational trajectories can now be discerned and policy-makers should help management and workers to move ahead along these paths. It will mean moving towards more horizontal communication, more intense communication inside and outside the firm, and delegating responsibility to the workers. The EU should stimulate research in this area and establish a forum for the exchange of experiences. The "Made in Europe" project established in connection with the TSER programme should be given high priority.

Building innovative networks

One of the most dramatic changes in the learning economy is the growing importance of networking and inter-firm co-operation in connection with innovation. It reflects the growing pace of change, but also the growing complexity of the innovation process, where each single innovation has to build upon several disparate technologies and where each technology has to combine several scientific disciplines. Public policy has different roles to play here. Competition policy may need to be changed if it is to respond to the full implications of the new regime. The formation of networks of firms and expert or learning institutions may be encouraged at different levels. At regional level, the formation of knowledge-intensive networks is a key to regional development. The different forms of regional networking in Europe have been analysed in the Cook TSER project (see for instance Cook, 1997, and Tödtling and Sedlacek, 1997). At European level, the formation of networks and consortia may help to create a more interdependent and coherent innovation system and make European industry more competitive. There are two caveats to be borne in mind here.

Firstly, it is difficult to design effective public policies in this area. The right parties must be brought together in small co-operative activities so that they can start to build trust (Lazaric and Lorenz, 1997). Public policy may try to support the formation of organisational routines which reduce the risks involved and to support grass roots initiatives to form new networks. Further research in this field is needed, including analyses of the basic roles of and reasons for network formation.

Secondly, given the rapid pace of change, geographically closed networks may block rather than stimulate innovation. At both regional and national levels, external networking may be crucial in order to stay ahead in the innovation race. Experiences gained in ESPRIT and the generally weak state of the European electronics industry point to the need for extra-European networking. Industrial districts may need greater interaction with external parties to avoid becoming locked into stagnating product areas. This implies a role for public policy in promoting the internationalisation of firms and the positioning of big European firms in global networks.

A new role for the service sector

TSER research indicates that change is currently most dramatic in the service sector and that this will remain so for the time being. The Hauknes-project (see for instance Hauknes, 1996, Hauknes, 1997 and Miles, 1996) has produced a a broad map of innovation in services while the the thematic network coordinated by Peter Wood has focused on the role of knowledge-intensive services.

These contributions show that better analytical understanding of the service sector is of key importance for policy-making. The preliminary results from research indicate that parts of the service sector - business services, communication services and other knowledge-intensive services - tend to become key sectors in relation to overall industrial dynamics. They become central nodes in the innovation system, gathering and codifying knowledge, connecting users and producers of knowledge and distributing knowledge world-wide (Wood, 1997, Antonelli, 1997, Tomlinson, 1997, and Tsounis, 1997). The traditional focus of industrial policy on the competitiveness of manufacturing firms is thus becoming less relevant. Services are increasingly important in their own right as providers of wealth and jobs and as strategic elements in innovation systems. Rethinking regulatory systems, including quality control systems, so that they promote rather than block innovation in these sectors is one policy task. Another is to promote more equal access to the services available to SMEs and marginal regions.

Integrating research institutions into the innovation system

In this report we have accepted elements of the hypothesis proposed by Gibbons et al. (1994) that we have entered a new mode of knowledge-creation where there is a much stronger connection between science and technology and where innovation will typically result from interaction among a multitude of actors in many different institutions and locations. These developments point to the need to integrate knowledge production at universities more closely with the innovation process But we have also warned against completely removing academic autonomy. The TSER thematic network coordinated by Keeble on "High-technology SMEs" illustrates different regional and national models in this respect (Keeble and Wilkinson, 1997). In the case of Chalmer's University in Sweden, the building of new technology-oriented transdisciplinary centres seem to have been a major element in a successful strategy. The TSER project coordinated by Jones-Evans has shown the diversity of attempts in Europe to get universities more effectively involved in innovation, and also some of the difficulties encountered. It is obvious that local conditions are important but certain principles may be followed. Matrix-forms of organisation (combining discipline-based departments with temporary inter-disciplinary centres), buffer organisations connecting universities with SMEs and the rotation of scholars between basic, applied and development research tasks are obvious policy initiatives in the new context.

Innovation policy in a wider perspective

So far, the focus has been on a set of policies that will increase our ability to innovate and adapt in a rapidly-changing environment. As indicated earlier in this chapter, the costs of rapid change and the negative effects of the learning economy may be substantial. A number of factors make it increasingly difficult to leave these changes to 'repair' policies. Large-scale income transfer is becoming more and more difficult in the context of globalised monetary regimes and Internet transactions. This is one reason for proposing a wider perspective on innovation policy. The other argument has to do with exploitation/exploration and integration/flexibility trade-offs. Moving rapidly ahead on a well-established technological trajectory might discriminate against long-term efforts to create new ones. The kind of innovation policy referred to in this section tackles the first problem and it may also help to solve the second one.

Responding to the inherent contradictions in the globalising learning economy

The package of innovation policies presented above emphasises the need to develop human resources and to integrate the different parts of the innovation system through networking and interaction. They affect the pace of innovation and change rather than its direction. The alternative to be discussed here is a need-oriented innovation policy explicitly aimed at tackling issues raised by the gathering pace of innovation and change. There are too many such needs to mention, so we will focus on two issues and use only the second of these to illustrate the basic principles involved.

They are:

- social and regional polarisation

- environmental threats from rapid change

While polarisation is a question of people and regions becoming economically and socially marginalised, the basic mechanism behind it increasingly has to do with competence, access to and participation in interactive learning. New ways of exploiting advanced user-friendly information technologies such as multi-media may be a key element in tackling these issues. Providing equal and effective access to information technology and communication systems in marginal regions is another one.

The environmental threats call for immense trans-disciplinary and multi-technological efforts. A strategy for sustainable growth will include measuring what is going on at global level, developing clean technologies in manufacturing and transport, changing the incentive structures in agriculture and forestry to use more environment-friendly techniques and changing our everyday way of life.

The parallel with post-war US military procurement of information technology and software

In this context it is interesting to consider the historical role of government in moulding the technological system around information and software technologies.[41] The major player in this field was, of course, the US military. According to Mowery and Langlois (1996), the impact of military demands was dramatic especially in the early history of the formation of a new technological system. While the impact of direct procurement was important in this phase, the most significant influence came through the construction of expert and learning institutions, academic training and subsidised access to computers. The fact that universities were used as the base for developing new knowledge in the field was critically important for the wide and rapid dissemination of the new technologies throughout the economy. The direct procurement of software became less and less effective in spill-over terms as it became increasingly oriented toward very specialised military needs. The authors also argue that attempts to design separate organisations outside universities and to pursue applied research aimed at specific private needs actually hinder the dissemination of knowledge.

These Cold War experiences, positive as well as negative, are worth considering. In preparing this report we found that new procurement policies, where public agencies organise private users in procurement aimed at saving energy, have been highly effective in affecting the direction of technical change (Edquist, 1997, and Westling, 1997). The software example from the US illustrates that this kind of 'incremental' policy, if supplemented by broader and more massive intervention, might have long-term effects on the overall dynamics of economic growth, fostering a new techno-economic paradigm. The idea is not to designate the technological winners of the future: nobody involved in the early stages of building the software knowledge infrastructure had any idea that this specific technology would revolutionise the economy and neither did those initiating the embryonic Internet. But the massive concentration of expertise on solving a set of common problems had the indirect effect of opening up radically new technological avenues.[42]

The environmental field is different from the military field in being closer to private markets. As new regulations are introduced, e.g. making the polluter pay, new markets for 'green products' are created. Also, the preferences of private and collective consumers are affected by 'environmental learning' as the non-sustainability and risks of following present strategies are realised. In the case of defence expenditure, the problems of 'spin-off' were much more intricate, often involving very specific use and a lot of secrecy. The 'weakness' of the environmental case is that the interest groups

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[41] This section is inspired by a Master Thesis on the relationships between the development of civilian and military technologies in the US (Rogaczewska, 1997).

[42] The analysis of CIS-data for Italy indicate according to Pianta and Sirilli (1997) that the impact of environmental policy on innovation has actually been stronger than policies directly oriented toward promoting innovation. This points to the enormous potential in co-ordinating innovation and environment policies.

behind the military industrial complex in the US were so much stronger than the popular alliances currently acting in the field of environmental issues.[43]

Building new technological systems

It is useful to think in terms of 'technological systems' as a special version of innovation systems (See Carlson, 1995 and several of the working papers from the Edquist project, such as for instance Smith, 1997, Johnson and Gregersen, 1997, and Malerba, 1997). A technological system is a combination of interrelated sectors and firms, a set of institutions and regulations characterising the rules of behaviour and the knowledge infrastructure connected to it, all focused on the same braodly defined technology. It may be argued that most of the innovation policies referred to above are well-suited to supporting existing technological systems but much less suited to helping to create new ones.

In the case of environmental innovation the following elements may be crucial for success in building a new technological system focused on environmental challenges:

- establishing flexible but demanding standards in an interaction between users and producers – this implies creating markets for green products and procurement policies involving private as well as public users;

- establishing institutes responsible for systematically measuring and evaluating the crucial environment parameters;

- stimulating experimental new initiatives in building training and research centres in crucial fields: such initiatives may be trans-disciplinary, combining elements from a small number of disciplines;

- strengthening the links between environmental policy, innovation policy and general economic policy.

Such a model, in which the core elements are market creation, building new knowledge infrastructure and policy coordination, might be used in other areas where the globalising learning economy tends to undermine its own logic.

It might also be regarded as a way of shaping the institutions and structure of production so that the innovation system becomes better suited to future market developments. One of the major results of the Verspagen project (see for instance Laursen, 1997, Verspagen, 1997, and Dalum, Laursen and Villumsen, 1997) is that the structure of production affects economic growth, and that Europe's lack of specialisation in electronics has slowed down growth and job creation. It has proved almost

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[43] For a TSER-project analysis of social movements and environmental policy see Jamison and Østbye (1997).

impossible to correct this weakness through science and technology policies (the experience gained in the ESPRIT programme illustrates this). The alternative sketched here takes into account the fact that the European market is one of the biggest in the world: setting new standards and creating new markets while at the same time building new technological systems may be seen as a way of shaping the future rather than trying to adjust to it when it has already become a fact.

A European agenda for innovation policy

There are different kinds of arguments for pursuing policies at European level. The implications of the principle of subsidiarity are not always clear and simple. To define what can be done as well, or better, at national or regional level is not just a technical issue. For instance, the mechanism that makes the EMU a natural step has to do with earlier steps to deregulate financial flows internationally.

Reviewing the different aspects of innovation policy discussed in this summary, we believe that action at European level should:

- use Europe's strength in world trade negotiations to avoid trade and competition regulations that hamper innovation, including radical innovations, or that block need-oriented innovation policies;

- stimulate international openness in knowledge production and distribution, and position European firms in global production networks and in global competition;

- ensure that the pressure for change is bearable for people and regions, and take greater responsibility for shaping their ability to absorb and cope with rapid change;

- encourage local experiments, assess the results and stimulate European policy development in the fields of human resource development, organisational change, network formation and linking industry to knowledge-intensive services and universities;

- establish flexible European standards in the field of knowledge production and in other areas where there are clear economies of scale.

- build European information infrastructures;

- initiate need-oriented innovation policies, create new markets and build new technological systems.

Many of these elements are already on the European agenda as specified in the Green Paper on innovation and in the outline of the next Framework Programme, although the TSER projects point to lacunae and bias in the agenda. In the follow-up to the Green Paper there is still a tendency to design policy on the basis of the linear model of thinking about innovation and to underestimate

certain aspects of innovation such as the role of human resources, competent users, demand factors and organisational change.

The new more need- and problem oriented approach of the fifth Framework Programme is much in line with the argument in this report. So is the emphasis given to environmental problems. At the same time, it bears a strong mark of having been designed by experts in natural science and technology. There are few references to social problems such as polarisation and the science-technology response is almost exclusively defined in terms of natural science and technology. Apparently, it has not been recognised that economic performance as well as the success in tackling environmental problems will reflect organisational capabilities and human resource development. Bringing in results from TSER-projects in the European policy discourse may help to correct this bias and give a better understanding of the potential contributions from the social sciences and the humanities.

Elements of an agenda for socio-economic research

The limited scope of this exercise – seven projects mainly focused on technology policy issues – does not allow us to propose an encompassing research agenda. Here we will just mention some topics that seem to need further research, given the general vision of the world presented in the report.

There is a need for at least three types of social science projects in the future. One type aims at integrating the results of projects with different orientations in terms of disciplines and objectives. Projects of the second type focus on specific sectors where too little is known. The third type are more directly concerned with supporting the policy agenda indicated in this report. In all cases the promotion of specific research projects may be combined with creating new infrastructure at the European level or with a European perspective.

The learning economy is a complex phenomenon where the social dimension is important because interactive learning is basically a social process, and because the learning economy has an impact on social patterns such as inclusion and exclusion. We need research that gives better understanding of the role of learning and knowledge in an economic perspective, but also inter-disciplinary research bringing together economists and sociologists, and experts in cognitive science and communication. We need to analyse the role of social cohesion and trust as a prerequisite for learning. Finally, we need to understand how learning takes place in time and space. What are the implications of information technology for the codification of knowledge and for the accessibility of different kinds of knowledge and learning across regional and national borders in the future? This is an agenda for both basic and applied research. Perhaps TSER projects should aim to establish one or two centres for studying the learning economy/society at European level.

In the field of economics, there is a particular need to continue examining the interaction between competition, co-operation and innovation as well as the role of intra- and inter-organisational change in radical innovation. The new modes of evolutionary, structuralist and institutionalist economic analysis referred to in Chapter 3 have been extremely useful in helping us understand the new features of the globalising learning economy. These analytical developments are not yet properly anchored in solid academic institutions. Consideration should therefore be given to establishing one or two European centres for studying evolutionary/structuralist economics. Another reason for doing

so is that this is an area where Europe has a lead over US economists, who are even more hampered by the neo-classical tradition.

Turning to specific problems, we would emphasise the need to understand the role of the service sectors in the overall dynamics of innovation and economic growth. It is also important to understand the changing extent of internationalisation and competition intensity. Labour market research and analysis of education and training also need to focus more explicitly on service sectors. There is a need for data sets, research institutions and taxonomies to sort out the heterogeneous nature of the service sectors. Again the formation of new centres with a European outlook may be useful.

Finally, our policy conclusions point to the need for a systematic and historical overview and assessment of policy development and especially for better understanding of the impact of government efforts to stimulate innovation in the context of need-oriented policies, not least relating to human resource development and environmental problems. Such projects might continue the analysis of past experiences with technological forecasting and with the use of interactive media to involve policy-makers. In this area it is important that new institutions combine autonomy from the executive European authorities with a close connection to the political process. Connecting these activities to the European Parliament could be a natural response to this dilemma. The aim of the research would be to give regional, national and European policy-makers inspiration for bold action in areas crucial for the sustainability of the learning economy and for Europe's long-term innovative capability.

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