1. Introduction

Willem Molle and Julia Djarova

OBJECTIVES, STRUCTURE[1]

Objective, Structure and Specificity of the Book

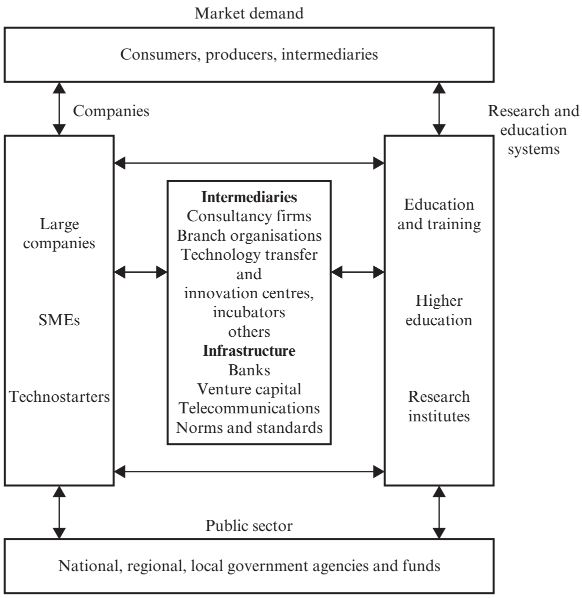
The EU has embraced the Lisbon Strategy and translated the strategic objectives into programmes with concrete action by the European Commission,[2] by the member countries and by their constituent regions. These actions involve considerable efforts to increase the level of R&D, knowledge and innovation, and to improve the effectiveness of investments in these fields. This should lead to greater productivity, competitiveness and hence welfare.

In the past, much work has been done to come to a better understanding of the anatomy of the problem ('Where does this lack of innovativeness come from?') and the effectiveness of the therapy ('Which instruments work under what conditions?'). Very helpful in this respect has been the introduction of the concept of the innovation system. Notwithstanding this progress, our understanding of the innovation system and the role of its various actors is still far from perfect.

The objective of the present book is to shed more light on a number of points that can improve the effectiveness of innovation efforts in the EU. We thereby focus on the interplay of the various actors involved. We do this with the help of a number of case studies of the main segments of the innovation system: public sector (governments), industry (firms) and R&D providers (research institutions and universities).

Innovation systems play a central role in enabling processes of innovation. Introduced by Freeman (1987), the national innovation system[3] (NIS) refers to the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies and useful knowledge. An important element of this is the incentive structure to improve the effectiveness of the system. Accordingly, the innovation system can be illustrated as in Figure 1.1.

For an innovation system to function effectively, all players in the system must utilise their innovative competencies as well as their capacity to collaborate. The various interrelations between the actors are indicated



Source: Adapted from Freeman (1987).

Figure 1.1 National innovation system

in Figure 1.1. Research and educational organisations interact with companies in order to develop and transfer know-how. Intermediaries play an important role in facilitating this transfer, as do the constituents of the knowledge infrastructure. The role of the public sector is to develop an environment conducive to innovation and offer interventions where the high risk involved in innovation cannot be covered by private initiatives. Market demand acts as the driving force for companies and defines much of the dynamics of the entire system. If elements and links are missing or are weak, the innovation system lacks efficiency and speed of adaptation to new developments in the outside world.

While it has been argued that these systems are primarily national (Lundvall, 1988), it is interesting to note that very little is known about how national borders affect the flow of technological information and capabilities (Nelson, 1988). More recent work has also highlighted the importance of the regional dimension in shaping innovation, and much analysis of innovation is now focused on the regional innovation system (Cooke and Morgan, 1998; Cooke, 2004). The constitution of players as well as their role stays the same as in the NIS. It should also be noted that the systems

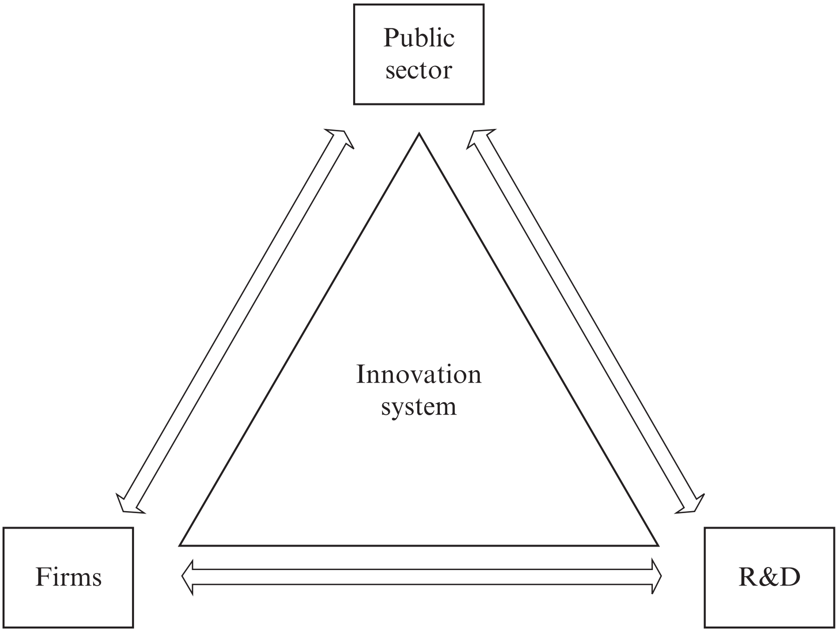


Figure 1.2 The three actors in the innovation system

of innovation are adapting themselves to technological developments. Accordingly, the institutional setting should by no means be seen as fixed, but rather as being in a continuous process of evolution.

The structure of the book follows the logic of the innovation system, where three main groups of actors and the links between them play an essential role in effective innovation. More specifically, the book is concerned with knowledge organisations, notably universities and private and public research units; firms from the private sector; and the public sector – European, national and local. In the first part of the book, we take the R&D sector as our point of departure; in the second part the business sector; and in the third part the public sector (see Figure 1.2).

The contributions to this book are all based on sound empirical analysis. They have been written by experts who have considerable experience in both the analytical and the operational aspects of the functioning of the innovation system. Moreover, some contributions are of particular interest in that they describe operational methodological improvements. All chapters are set in the framework of a thorough review of the existing literature on the subject.

Objective and Structure of this Introductory Chapter

The objective we pursue in this chapter is to present a synopsis of the main results of the various contributions to this book and to draw some general policy conclusions from them.

We structure this chapter as follows: first, we provide a brief introduction to the main characteristics and trends of the innovation system; second, we detail the changed role of the various actors in the system. Subsequently we take the standpoints of the three main groups of actors: the R&D sector; the business sector; and the public sector. For each we highlight the value added of this book by setting the results of the contributions to this book against the background of the main insights from the literature.

THE INNOVATION SYSTEM: THREE LAYERS AND THREE PLAYERS (GROUPS OF ACTORS)

Innovation

Innovation accounts for the overwhelming majority of productivity gains in most of the world's leading economies. In turn, productivity increments are the key to enhanced competitiveness. In short, innovation is the driver of competitiveness at the international, national and regional economic levels. Hence understanding the role of innovation in promoting economic development is essential to policy makers.[4]

This calls for a definition of innovation. In certain policy circles the term innovation has become misleadingly synonymous with science, R&D and industry. But there is more to it than mere technical change. Hence a broader definition is needed. This has been acknowledged by the UK's National Endowment for Science, Technology and Arts (NESTA, 2007), which warned that 'Science ≠ Innovation'. Indeed, an overly narrow technical definition of innovation has become inappropriate as national and regional wealth is increasingly generated via services and business model innovation. Rubalcaba (2007) notes that services constitute 70% of advanced economies, so their innovation process will be essential for (determining) growth. Yet the majority of studies regarding innovation have used the industrial sector as a reference, putting the tertiary sector to one side. In summary, it is best to adopt a broad definition of innovation. This is not a novelty. Classical writers have already indicated the way. For instance, Schumpeter (1934) interpreted innovation as changes to products, processes and organisations that create or increase value. A more recent broad definition of innovation is simply: 'new products, business processes and organic changes that create wealth'.

Three-player Innovation System

Innovations do not come about in isolation. They are engendered by a complex interplay of actors in specific institutional and regulatory environments. This has been termed 'systems of innovation'.

As discussed earlier, systems of innovation include actors such as firms, R&D establishments, universities and other higher education institutions (HEIs), providers of consultancy and technical services, state authorities and regulatory bodies, development agencies and other supporting and intermediary institutions (e.g. Chang and Chen, 2004). They are generally grouped into three: the knowledge infrastructure (R&D, HEI etc.), the corporate sector (both multinationals and small and medium-sized enterprises – SMEs); and government. The driver of the system is the firm that responds to market demands.

However, innovation and knowledge creation depend on a series of factors such as quality of staff, incentive structure, resources available etc. The ability of firms to successfully produce and implement innovations in a commercial way depends very much on the environment they have to work in: competitors, customers, human capital, knowledge infrastructure, institutions that facilitate diffusion, regulation and legislation, untraded interdependencies and a host of other factors (OECD, 1997a). For both knowledge providers and knowledge appliers, external links to the national and global economy are increasingly important. System means that there is interaction: this happens through both formal and informal networks.

Three-layer System of Innovation

In the past the main level of operation has been the national level. Several forces have been driving major changes to this picture:

- *Globalisation* has led to the internationalisation of markets and the possibility of splitting certain functions such as R&D and locate them in different places around the globe. Globalisation poses an increased challenge to all actors to become more competitive.
- *Europeanisation* has led to the centralisation of key R&D tasks and the adoption of common standards for products. The various enlargements of the EU have led to a wide diversity of situations. Europeanisation poses the challenge of realising a policy system capable of addressing this diversity in problems and goals.

- *Regionalisation* has led to stronger roles for regional clusters of innovative capacity. It poses the challenge to increase the capacity of regional authorities to strengthen competitive advantages.

Together these driving forces lead to a three-level system of innovation: European, national and regional.

Changing Interplay of the Three Key Actors of the Innovation System

The relationships between the three actors in the innovation system have changed over time. In many countries, each of these actors existed very much on its own terms, with little relation to the others. Firms did their own R&D in private R&D centres. They tried to shelter their results as much as possible from the competition. Governments supported public R&D, the results of which were considered as public goods. Moreover, governments tried to foster in general the conditions for a healthy corporate sector. This made for very simple innovation systems.

The relations between the main actors in the innovation system have changed in recent decades (see the evidence in the other chapters of this book). As a consequence, innovation systems are now much more diversified and complex. A few such changes are as follows:

- The locus of private sector innovation has shifted away from large private (firm-specific) R&D units towards scientific research sourced from universities and public-funded research centres. In the past decades, the central R&D laboratories of large international firms have been reduced in scale and number to save costs.
- Research institutes have become more involved in private sector innovation by stimulating spin-offs and by securing extra resources from the commercialisation of knowledge.
- Governments have become much more involved by setting up varieties of structures that facilitate the flows of knowledge.

Together these tendencies have blurred the precise borders that used to separate the domains of each of the three actors. This has led to interactive systems in which government, knowledge providers and industry operate in a synchronised way (the 'Three-Helix' system as discussed in Etzkowitz and Leydesdorff, 1997). Such three-way relationships were pioneered in the innovation systems of Finland and Sweden, and are now well embedded in the systems of the EU, member countries and regions.

FOCUS: R&D

Institutions

Innovations should lead to marketable products. This does not, however, mean that firms are the actors best equipped to take the necessary in-house steps to come to innovation. Many carry out only part of their innovative work internally. Most (including SMEs) perform development activities in house (the D segment of R&D). Many multinationals also carry out a significant part of their research (the R part of R&D) in specialised company centres. However, many more R&D activities are outsourced to knowledge institutions.

The contracted R&D is only a part of the total effort on R&D. Indeed, most research is not industry (demand) driven. It is done by specialised organisations such as universities and R&D centres, some of which are associated to higher education institutions (HEI). Most of these institutions in the EU depend on public money. Their research is science driven. The members of the staff of such knowledge institutes are motivated by the enhancement of science and the possibility of publishing the scientific results. They are less oriented towards the practical use of their work. In this way, much of the commercial potential of the research risks staying unused. There is a gap between the world of science and that of industry (for further illustration see Box 1.1) that influences economic growth negatively.[5] Hence any effort to bridge this gap contributes to economic growth.

BOX 1.1 THE 'GAP' BETWEEN THE WORLD OF BUSINESS AND THAT OF SCIENCE

World of business	World of science
● Seeks profit and market shares	● Seeks academic eminence
● R&D for private use	● R&D for moving frontiers
● Short-term orientation	● Long-term orientation
● Information is for commercialisation	● Information is for disclosure
● Interprets information versus opportunities	● Interprets information in the context of advancing science
● Communicates via prices/brands	● Communicates via publications

For instance, OECD (2001) has shown that the interaction between universities, private firms and public R&D institutes had a positive influence on growth. This justifies government intervention to stimulate the quality of such institutions. In recent years, many efforts have been made to improve the quality of this interaction and thereby increase the growth and innovation effects of any investments made. Many financial and non-financial incentives are directed to universities and public R&D institutes. They aim to encourage entrepreneurship and, as a consequence, the number of high-technology start-up companies and technology transfer centres. Others aim to stimulate the industry to partner with universities and R&D public institutes in applied science development and its commercialisation.

The problem of the interaction between science and industry is the focus of some of the contributors to this book. Therefore we shall now go into more detail on the issues of R&D spin-offs and transfer mechanisms.

R&D (University) Spin-offs

One way to realise a better commercial use of R&D results from public institutes is to involve the inventors in academia and similar institutions in the commercialisation process.[6] The main incentive for them to do this while staying within the academic institute is to generate extra resources (financial and human) that permit them to make further progress in their scientific work. In some cases, however, there is also the motive to enter into business with possibilities for remuneration exceeding that provided by the R&D institute. The way in which this process takes place is by the transfer of knowledge from the university (or R&D institute) to a new venture in which the (group of) inventor(s) participate(s) actively.[7]

The attitude of universities towards commercialisation has changed over time. More and more universities are now aware of the importance of active involvement in stimulating entrepreneurial activities that commercialise knowledge (Etzkowitz, 1998). The change from a passive or even negative attitude towards a stimulating one is not always easy. It takes the creation of the right organisational context, the systematic identification of commercially interesting developments and of persons with entrepreneurial spirit, the setting up of an incentive structure etc. (see, e.g., O'Shea et al., 2004).

The process by which university spin-offs (USOs) are successfully created and developed has been studied intensively. Wright et al. (2007) distinguish between several types of spin-off. They detail the different institutional environments for successful incubation. They describe the pitfalls a new venture has to avoid to develop successfully, stressing the need for building teams of people with different competencies and for ensuring access to finance. Indeed, the success of USOs is crucially dependent on the speed with which the new venture can overcome a number of problems such as lack of credibility with clients, financiers etc.[8]

A number of universities have used their technology transfer offices as incubators of USOs. They provide them with facilities in the matter of offices and mediate to find the elements often lacking among academic entrepreneurs, such as management skills, (venture) capital and so on. Sometimes they themselves act as key investors as they use the rewards of earlier ventures to stimulate new ones. To that end they have sometimes set up staff that can support the entire start-up phase and bring the investment to the market as soon as it has reached some stage of maturity. However, many other universities still shy away from such involvement. This attitude limits the number of USOs and thus the possibilities for dynamic innovative ventures.

In his contribution to this volume (Chapter 2) Hans Wissema addresses the problem faced by universities in creating structures that facilitate such spin-offs. He focuses on technostarters – spin-offs from technical universities. Such technostarters are particularly interesting as a subject, as they make an indispensable contribution to the economy by creating new employment at a higher professional level. Wissema uses the example of Cambridge (UK), where a lucky constellation of factors has created a cluster of knowledge institutes and new innovative firms, some of which were offsprings of the university. The university has acknowledged the importance of technostarters and now deliberately fosters their development, supported by government grants. This support takes the form of facilities such as a science park, an innovation centre etc. Another role model is Leuven University (Belgium), which has also done much for starters, focusing more on specialised research centres (such as microelectronics).[9] Wissema argues that universities that assume such extended responsibilities for support to the regional environment (in supporting technostarters) do not neglect their prime task of research but can actually see this enhanced by the stronger 'infrastructure' and financial base that it creates.[10]

This latter recommendation supports the one that was drawn from a study into a larger sample of practical experiences in different regions in the EU (Huntingford and Frosini, 2007, pp. 81–92). They divide the whole process of spin-offs and start-ups into five stages: awareness raising and entrepreneurial education; checking the feasibility of the spin-off; preparation for foundation of the company; actual creation of the company; support during the first five years. They see this as a role not only for the university, but point to the responsibility of other regional actors. In particular, the regional government needs to make sure that complementary support is provided where needed. These support activities should be specifically tailored to the needs of R&D-intensive starters; applying general measures to this category of starters does not lead to success (Storey and Tether, 1998).

Transfer Mechanisms

There is a second way to stimulate the commercial use of the results of publicly financed R&D. That is by taking away the barriers to the transfer to the market of scientific and technological know-how from R&D establishments. Indeed, the mere production of knowledge does not by itself lead to more competitiveness and hence growth. The knowledge needs to be channelled to firms that can actually use it in their production and production processes. However, information does not always flow easily and hence many of the results risk staying under- or even un-utilised. So it is important to increase the effectiveness of this link.

The deficiencies in the industry–science link (illustrated by Box 1.1 above) are well documented in the literature; they have been cynically stated to stem from academics being only interested in an extra source of finance, and industry only in testing at lower cost than consultants (Cooke et al., 2000). Much has been done to improve the relation between knowledge institutes and the corporate sector. Solutions to the problem often take the university as the starting point. The problem is then subdivided into more specific problems about the context, the structure and the processes that universities use to bring their knowledge to the market. A number of European research universities have experimented with different forms. From these experiments a few conclusions can be drawn as to important success factors (Debackere and Vleugelers, 2005):

- *Knowledge generation* The knowledge base needs to provide for excellence in certain areas. A good combination of basic and applied research is instrumental to the identification of commercially interesting uses of scientific knowledge.
- *Knowledge transfer capacities* The university needs to show that it is committed to commercial uses as part of its central mission, networking between university staff with industry at all levels.
- *Organizational structures* A decentralised model where research groups receive incentives that stimulate their direct and active involvement in the exploitation of their research.
- *Supporting services* Specialised central services offering intellectual property management.

Given its key importance for competitiveness and growth, the issue of increasing the effectiveness of the R&D–industry link has been high on the policy agenda. Efforts to improve the link have been intensified. However, it remains unclear to what extent these efforts bore the fruits expected from them. Methods to evaluate the impact of policy efforts in this domain are rather deficient. To improve on that situation, IDEA[11] has developed a new method (the multidimensional innovation impact assessment method; MI^2A). This method distinguishes between the economic (e.g. induced value added), fiscal (returns to government due to taxes on income profits etc.), scientific (e.g. knowledge) and technological (e.g. patents) impacts.

Arnold Verbeek and his colleagues have applied that method to the case of the Flemish centres of excellence. They show (in Chapter 3) that these centres play a major role in strengthening the knowledge base in their specific areas (sectors) and in stimulating international competitiveness of Flemish companies. The positive fiscal effects they engender mean that the net cost to the government of their activities is much lower than originally budgeted.

The role of university knowledge transfer activity has received much attention from policy makers. This is based partly on the assumption that proximity to a university can offer advantages in terms of the quantity and quality of knowledge exchanged with local businesses, thus stimulating greater innovation in the business base and leading to economic benefits to their region. However, the importance of proximity for local development is highly debated. Some writers argue that, at present, technology effectively allows instant access to information and communication anywhere on the globe.[12] If this were true, the premise of a policy of stimulating local innovation would collapse. Others find that the proximity factor is very important, and that contacts between partners are subject to strong distance decay. For knowledge-intensive SMEs in particular, proximity of partners is a determining factor for their performance (Arndt and Sternberg, 2000). In the EU-25 context only the innovative efforts pursued within a 180-minute travel radius have a positive and significant impact on regional growth performance (Rodríguez-Pose and Crescenzi, 2006).

In order to explore the geography of university knowledge transfer activity in practice, Adrian Healy reports (in Chapter 4) on three regions in the UK: South East England, London and the East of England. In each case interviews were undertaken with a sample of universities, particular departments and key academics. The research found a complicated and uneven geography of knowledge transfer activity that owes as much to individual contacts and interests as to corporate strategy or spatial factors. The research also identified that distinct spatial patterns are discernible between different knowledge transfer programmes, providing important pointers to policy makers and regional strategists. The research suggests that in knowledge transfer activity, consideration should be given to notions of relational spaces next to traditional conceptions of geographical proximity.

FOCUS: FIRMS

The Drivers of Firm Innovation

A key role for driving innovation is the behaviour of the entrepreneur (Schumpeter, 1934). In the face of competition and declining profits, entrepreneurs are driven to make technical and financial innovations. The spurts of activity resulting from these innovations generate economic growth. Through a process of 'creative destruction' waves of innovation hit different industries at different points in time. Firms have an incentive to engage in innovative activities because of the expectation that new technologies will generate monopoly profits – at least until the new technology becomes public knowledge (Grossman and Helpman, 1991).[13]

However, this technical concept is not the only valid one. In line with the broad definition of innovation we adopted for this book, we also have to see what other factors may be of influence. One such factor is the capital of knowledge that is available in a certain area (Antonelli, 2006) that permits combinations of product and production process innovations. The internal organisation of a firm can also have a strong impact on its innovation performance. Organisational rigidities in innovation projects have a negative impact on productivity (Lööf and Heshmati, 2002). A survey of studies in the management literature on the determinants of organisational innovation identified three main determinants (Read, 2000):

- management support for an innovative culture;
- a customer/market focus;
- a high level of internal and external communication/networking.

Innovative ideas at company level come from many different sources.[14] Very important among them is the market: indeed, users provide many ideas for improvement. Next to this is internal and external R&D. Innovation is moreover stimulated by discussions with other companies. Finally, the acquisition of equipment, notably ICT, plays a significant role. ICT is a major motor for innovation and hence for growth in the knowledge-based economy. There are large differences in ICT adoption levels by firms over the EU space. This suggests a very unequal geographical pattern of ensuing innovation (Vicente and Lopez, 2006). Stimulating the performance in the low adoption areas by the enhancement of the use of ICT by firms requires a better understanding of the ICT diffusion process. Numerous studies have been made into the subject (see the review by Hollenstein, 2004).[15] Many limit themselves to the problem of diffusion. Yet a more detailed understanding is needed of the factors that determine the successful implementation of ICT by SMEs to design good policies that can stimulate innovation, notably by firms in countries that are catching up with the average EU living standard (see Chapter 7). This is all the more relevant as empirical studies show that the competitiveness of SMEs (in terms of export performance) in the countries of Central and Eastern Europe is strongly dependent on ICT, notably the judicious use of the Internet (Clarke, 2008).

This is exactly the approach that is followed in the chapter by Jacob Dencik and Julia Djarova (Chapter 5). They have made an investigation at the firm level into the dynamics of ICT adoption in a number of countries in Central and Eastern Europe. They found that ICT is one of the main factors determining the performance of firms, both through improved efficiency of the production process and the increased innovativeness of firms. A major finding of the study was that the regulatory environment strongly influences (facilitates or inhibits) the take-up and use of ICT among firms. The surveyed firms found that the most constraining elements were inadequate education and training, and inappropriate taxation. The authors define six policy areas where priority government action is needed in order to create an environment for firms that is conducive to further ICT use and hence for the innovative performance of firms.

The Key Role of Finance

Numerous empirical studies have demonstrated that one of the key determinants of innovation is access to funding (in the form of cash flow, bank loans, venture capital, stock exchange etc). Many innovative companies use a 'bootstrapping' model of finance, depending on their own resources, revenues and prioritisation. Others prefer 'smart money': funding that comes with advice via business experts, business angels, active investors etc.[16]

In many cases the money from private sources is not enough. Indeed, in quite a few cases the market is not performing well. Theoretical studies show that external financing is likely to stop short of the optimum (Bergemann and Hege, 2005), resulting in a loss of opportunities and waste of resources. Empirical studies show that the internal sources (cash flow) are often insufficient (see, e.g., Bond et al., 2003) and that external sources are rather expensive while the availability of funds is in many markets limited, due to information gaps and other market imperfections (Hall, 2005).

Investments in R&D are intangible and uncertainties are always attached to such investment. In addition, in the 'markets' for science and technology there are clear market imperfections. Linking demand and supply cannot be done by such market mechanisms as price, for instance. This is why national governments saw it for a long time as their task to invest in R&D. The justification for policies to promote company R&D is based on the same argument: for the sake of society as a whole, it may be justified to provide subsidies for corporate R&D in order to persuade individual firms to take more risk and work on longer time horizons than they would have done for company reasons only. Especially justifiable is the government intervention in the case of SMEs, where the regular sources of finance are often not available (EC, 2007). It is also the case for projects of large firms, where the risks are fairly large. Most governments have set up schemes to provide funds to firms to stimulate their innovative activities and especially their R&D.[17]

One of the other main instruments by which the government tries to stimulate R&D in business is by providing direct financial support. It assumes thereby that such support will enhance the size and the effectiveness of the efforts of the firm and thus enhance the competitiveness of the firm. The question is, however, whether the assumptions on which this action is based do indeed hold in practice and to what extent the financial resources spent lead to the expected result.

The evaluations of government-supported finance schemes (based on microdata) are generally positive; they tend to conclude that private R&D has increased by the same amount as the government stimulus. However, there are quite a few methodological problems to be resolved before this inference can be upheld with confidence (see, e.g., Klette et al., 2000; Hall and Van Reenen, 2000; Hall, 2005).

A group of researchers at IDEA has attacked this problem. Geert Steurs et al. show in their contribution to this book (Chapter 6) that the usual method of using input and output measures cannot give a good answer to the question at hand. What is needed is a measure of the change in the behaviour of the firm due to the subsidy. This extra effort (additional to the present one) can be called 'behavioural additionality'. It can be measured in terms of increases in the size of the R&D programmes, in the speed with which they are executed and the number of partners involved. Steurs et al. make their method operational in their analysis of the effects of subsidies by a government agency in Flanders. Their findings are clear: subsidies have a positive effect on the efforts of firms on all three scores (size, speed, partners). They are thus important drivers of firm performance.

FOCUS: PUBLIC SECTOR

Role of the Public Sector

Economic systems alone cannot always provide solutions to the problems they are confronted with. Governments have to intervene to correct such failures. In matters of innovation this is true as well. The literature gives abundant reasons for a strong role of the government (e.g. OECD, 1997b). In the previous sections of this chapter, we have given examples of cases where government intervention is essential in coming to a solution. As mentioned earlier, much research in government-sponsored R&D centres is science driven, and its application in commercial use does not come about without government policies that stimulate the relation between the R&D centre and the corporate sector. The same is true for innovation within the corporate sector, where government stimuli can help to overcome the barriers to development.

In discussing the role of government, it has been traditional to refer to that of national governments. However, this view is now completely inadequate for reasons indicated earlier in this chapter. Indeed, in Europe a three-layer structure of government has developed in which the main actors are the European Commission, the national governments and the regional governments. The distribution of responsibilities between the actors in this multi-layered government system has been changing over time (see, e.g., Jordan and Schout, 2006; Molle, 2006). Over the first three decades of the existence of the EU, changes in this distribution between the EU and national states have come about as answers to specific challenges. This has led to unbalanced situations. Since 1986 the principle of subsidiarity has governed this distribution: it says that the EU should do only what cannot be done efficiently at the national or regional level. The distribution between national governments and the regions has also changed. Partly under the impetus of the EU, many countries have empowered their regions to take responsibility for economic development matters.

European Policies and Systems

The EU policy on innovation has gradually evolved (EC, 2003a; Peterson and Sharp, 1998; Nauwelaers and Wintjes, 2008). An assessment of the various segments of innovation policy on the subsidiarity criteria shows that there are good reasons for involvement at the EU level (Horst et al., 2006). The 'economies of scale' argument applies notably to large R&D projects characterised by indivisibilities. In this way the 7th Framework Programme (FP7) funds such activities to pool and leverage resources, foster human capital and excellence. The EU also supports innovation in SMEs. Its involvement there is justified as it reduces the cost of regulation and promotes the policy learning between member states.

The European innovation system is limited in its ambitions with respect to R&D and firms to the elements just mentioned. Its main feature is its steering of the efforts of national and regional governments to improve the innovation systems on these levels. This involves a great deal of coordination in order to improve consistency of efforts. This coordination is ensured in two ways:

- a bottom-up process, in which the specificities of the regional and national layers are framed in a EU setting of priorities and rules; and
- a top-down process in which EU priorities are set, benchmarks defined and the performance of the national and regional layers constantly monitored against the objectives at the EU level.

In his contribution to this volume (Chapter 7) Willem Molle describes how the EU has set its innovation policy in the framework of the realisation of its overriding goal to improve its competitive position in the global knowledge economy. He indicates, however, that the EU has limited chances to realise this goal through the deployment of instruments available under the heading of innovation policy. Much has to be realised by coordinating national and regional efforts, and this coordination in itself is unlikely to be effective without adequate frameworks for coordination and without some financial stimuli. The EU systems for innovation policy are inadequate on both scores. However, in the framework of EU cohesion policy, highly sophisticated and effective coordination and implementation systems have been elaborated for which very considerable sums are available. The EU has put this system to the use of innovation. Molle concludes that this integration of part of the cohesion system with the European innovation system appears distorted in theory but is in practice quite effective. He makes a number of suggestions to further optimise the coordination mechanisms.

National Governments

The national innovation capacity can be defined as the ability of a country to produce and commercialise a flow of innovative technology over the long term. The internationalisation of R&D has changed profoundly the room for manoeuvre of national governments, in particular those of small countries (Spithoven and Teirlinck, 2005). The national innovative capacity depends to a large extent on the strength of a nation's common innovation infrastructure and environment for innovation, its industrial clusters and the strength of the linkages between the two (Furman et al., 2002). There is considerable debate about the contribution of each of these elements. Yet some factors stand out as important: first, the level of spending on R&D; and second the productivity of R&D outlays. R&D productivity is determined by factors that stimulate the effectiveness with which R&D is translated into usable products. These in turn are influenced by factors such as openness of universities to private sector funds and private sector commercialisation of innovations.

The factors cited above can be influenced by government measures in order to improve the performance of the system. To that end, an evaluation has to be made of the present situation and measures taken to improve the weak points.

In their contribution to this volume (Chapter 8) Julia Djarova and Walter Zegveld stress the importance of national innovation systems as essential building blocks of the multi-layer structure of innovation policy in the EU. However, they argue that the traditional NIS approach suffers from a number of inadequacies, related to a lack of effectiveness due to poor coordination of the efforts of the various actors involved. They stress the importance of an innovation policy mix consisting of a set of interrelated policy measures that responds to specific combinations of challenges. The policy mix needs to govern all stages of the policy cycle: design, implementation and evaluation. Policy mixes fall into the area of responsibilities of different government departments and can thus only be effective when they are well coordinated. The authors argue that this is best done at a very high level of authority.

Regional Governments

Regions are the building blocks of Europe's economy: it is at the level of the region that the factors of competitiveness and innovation can be identified,[18] and effective tools for sustainable, endogenous development applied. It is at the regional level that the notion of innovation system finds its most concrete application in the form of regional innovation systems (RIS). The task of the regional governments is essentially to assess the component factors of the regional innovation system and to improve them where possible.

The first component is formed by the regional R&D organisations. In principle, these are easy to identify. They constitute the backbone of the regional knowledge infrastructure. Other elements in that group are higher education institutions (HEIs), which provide the human capital most ready to enter into innovative activities of the region.[19] Regional governments can influence the innovative climate of the region by stimulating these institutes to take entrepreneurial attitudes (in line with those discussed by Wissema in Chapter 2 of this book).

The second component is formed by firms. The innovative capacity of regional firms is not always easy to identify, but on many occasions simple surveys permit taking stock. The important element in this respect is not the individual firm, but the quality and density of business network structures: entrepreneurs in knowledge-based firms, when compared with traditional firms, invest more time in networking and also build more focused networks.[20]

The innovative attitude of firms is determined by many external factors that support access to knowledge and diffusion of knowledge. One important element here is the quality of key personnel.[21]

The role of the regional government is important, as it is the main actor capable of developing, in a systematic way, the RIS. This role consists first in the building of effective linkages that transfer knowledge and innovation within and beyond the regional economy, especially involving technology-based industries and businesses.[22] However, this is not sufficient. The development of the RIS should also address factors such as social capacity, networks and institutional thickness, and assist the functioning of untraded interdependencies.[23] Indeed, experience has shown that the success factors for an RIS are to a large extent organisational and cultural (Cooke et al., 1997): culture of cooperation, associative governance, ability and experience to carry out institutional change; coordination and public–private consensus and existing interface mechanisms located in scientific, technological productive and financial fields. The policy makers themselves need to give proof of entrepreneurship; experiments with new approaches should be adopted and lessons drawn from them (the learning region – Morgan, 1997). Finally, the regional government needs to address the improvement of the regional business climate in general.[24]

In those regions where the factors that determine innovation are weak (in particular most new member states), the role of the government is more pronounced (see, e.g., Morgan and Nauwelaers, 2003). Depending on the specific situation in a region, the role of the government may indeed be more facilitating or dirigiste (Braczyk, et al., 1998).[25]

The policy lessons that result from the previous survey of the literature are not easy to put into practice. Many difficulties need to be overcome. The first is the mere assessment of the actual situation. If it is a question of only one region, a qualitative description of the many components seems certainly possible. However, when it comes to benchmarking, a comparison with other regions or with average values will be necessary. This supposes the quantification of a number of variables. This seems fairly easy as far as the basic components (such as R&D activity) are concerned, but almost impossible as far as the cultural components (such as untraded interdependencies) are concerned. Various typologies of RIS have been constructed (see Chapter 7) on the basis of the available information. Their capacity to guide policy making in the whole EU is limited, however, due to lack of data (particularly for the new member states).

In order to improve on that state of affairs, Marta Makiewicz, Robert Pollock and Paulina Fabrowska analyse (in Chapter 9) the situation in the largest of the new member states: Poland. Notwithstanding the important improvements realised over the past decades, the country and all its regions rank low on the EU innovation monitor. There are serious deficiencies in the quasi-totality of the RIS of the country. The authors set out to get to grips with the situation. They first define four types of regions with their specific models of innovation and policy intervention. They next assemble new data for all the Polish regions on the basic components of the RIS and construct an index that produces a ranking of the regions in terms of innovativeness. This shows that the country has effectively only one region with an innovative potential that compares to the rest of the EU: the capital city Warsaw. All the other RISs are rather weak. The authors conclude that the country needs to make a very great effort to improve the situation in all its regions. The authors argue that these efforts should be carefully designed so as to fit the particular situation of each region. Finally they plead for a more in-depth study of each of these regions to determine quickly the policy packages that will best suit their particular problems and ambitions.

SOME CONCLUSIONS AND KEY MESSAGES

Recall of Key Features of this Book

This book is based on the view that innovation systems (e.g. European, national, regional) have become increasingly complex and that their dynamics are dependent on a multitude of interrelated factors. Thus what is essential are not the individual components, but the systemic factors. Hence it is important to study the relationships between the actors in an innovation system. We consider the innovation system as a three-player (R&D, firms and the public sector) and three-layer system (regional, national and European). Our view is that the solution to the problems is not only in the R&D sector, nor in the industry sector, nor in the public sector. It is in fact at the same time in all of the 3×3 elements of the system and in the interrelations between them.

In line with this view, we clustered the individual contributions according to this 'three-player, three-layer concept'. We asked each contributor to pay due attention to the interrelations between the actors (players) and levels (layers).

Finally, we can now list the main conclusions and the main messages that can be drawn from our work.

Conclusions

The results of the cooperative effort of the contributors to this book consist first of a set of interesting new insights into important problems that confront the major actors in the innovation system and their relationship. These can be listed by main group of actors as follows:

- *R&D institutes* The introduction of more entrepreneurial activities into these institutes should improve both their academic output and the success of innovation of the private sector.
- *Firms* The improvement of the regulatory and institutional environment of firms enhances their efforts in matters of R&D and in networking, resulting in increased innovation and a better market position.
- *Public authorities* The streamlining of the present set-up and the better attribution of roles over the various authorities involved should reduce the cost of coordination (higher efficiency) and improve the results (higher effectiveness).

Key Messages

The various contributions to the book have an important aspect in common: all challenge the traditional (and sometimes simplistic) view of the problem at hand and develop the more modern (and often more complicated) approach to the issues. In this common vein the various authors all make suggestions for increasing the effectiveness of innovation policy. These can be specified by subject (chapter) as follows:

- The role of the universities and public R&D institutions has traditionally been limited to conducting research and teaching students. A more modern view of their role stresses the importance of adding economic value through enterprising. In view of the latest development of 'out-of-house' rather than 'in-house' research for many private companies, the team suggests forms of organisation of knowledge institutes and of government regulation concerning these institutes.

- Technology transfer has been seen for a long time as a one-way transaction. R&D organisations provided technology to some business directly or to business in general through patenting. Technology transfer nowadays is multidimensional and has brought to life new organisational forms such as centres of excellence, technology institutes etc., where the R&D–industry link is supported by policy instruments. The effects of traditional technology transfer have been studied quite extensively in the past. The study of the effects of the new forms of transfer needs a different approach, such as the multidimensional impact assessment method developed in Chapter 3.
- Geographical proximity used to be the prominent feature of knowledge transfer. This is no longer the case. Consideration should now be given to notions of relational density and intensity next to traditional conceptions of the cost of overcoming distance. The role of geographical proximity is also challenged by young graduates, choosing their research facilities over a wide area. The factors of choice here have moved up even higher than the national level.
- Entrepreneurship has traditionally been seen as a characteristic inherent in an individual person that can hardly be transferred let alone copied. In this perspective there is no role for government intervention on the subject. Today we argue that one can develop entrepreneurial capacities, and that these are essential for innovation. Consequently, public authorities at regional, national and European level support entrepreneurship. Financial support instruments are increasing in variety and in number. The issue, however, is: does the provision of financial stimuli lead to the expected results? Our team has argued that the usual method of using input and output measures cannot give a satisfactory answer. What is important is to measure the change in the behaviour of the firm that receives the subsidy. Only in such a way can one tackle the persistent problem of building up sufficient learning capacity in the system.
- Best practice has been promoted as a learning tool for many public authorities at different levels. Searching for best practice the contributions in this book that are concerned with the regional, national and European aspect of innovation policies, one becomes confused as the transferability of the specific results seems limited. We conclude from this that it is more important to take account of the consistency of the efforts of the various players. Thus interrelationship should be built into the decision-making mechanisms at all levels for all actors.

- The various elements of the innovation system have traditionally been developed in isolation, minimising the effort of coordination. This has been identified as a major hindrance to effective and efficient innovation systems at the European, national and regional level. We argue that the mere stepping up of coordination is likely to add to inefficiencies and unlikely to be effective without adequate frameworks and without financial stimuli. We find the EU systems for innovation policy lacking on both scores. However, the integration of innovation into the EU cohesion system is a promising way to increase effectiveness.
- Coordination that overrules the departmental (sectoral) approach to decision making seems to be a key factor for success for national public authorities in their efforts under the heading of innovation policy. The challenge is to 'overrule' the traditional governmental structure and find a form that can prove workable. Although we find the pace with which such forms come to life too slow, there is a positive tendency in this respect.
- Benchmarking exercises have traditionally been promoted with the idea that the making of a typology of regions could provide a menu of specific models of innovation and policy interventions. Notwithstanding the importance of benchmarking as an instrument, we argue that cultural components such as untraded interdependencies are almost impossible to quantify. So a more 'personalised' approach to each area based on detailed SWOT (strengths, weaknesses, opportunities and threats) analyses is needed for each national and regional authority.

NOTES

1. We acknowledge the support of Roderick van 't Hoff for effective literature search.
2. Not only DG Research but also various other Directorates General such as Employment and notably the one with an important spending capacity, i.e. Regional Policy (see Molle, 2007, ch. 12).
3. For a historical overview of the development of the concept see Freeman (1995); for a description of a set of national systems see Nelson (1993); and for some best practices in the application of the concept see OECD (1997a).
4. For the role of innovation in the economy, see, e.g., Freeman and Soete (1997). For the role of government, see, e.g., OECD (1997b); von Hippel (1988). A good example of why policy makers need to have a more inclusive understanding of innovation is the case of Ireland. Ireland has traditionally had low levels of R&D spend per capita and yet is one of the most successful economies in the EU, in terms of GDP growth and GDP per capita, and is rightly termed the 'Celtic Tiger'. Ireland's success is built on the prudent application of Structural Funds for skills development and infrastructure, fiscal reform, foreign direct investment and the presence of a cohort of indigenous internationalised

companies whose innovation models relate to redesigning their business processes. See in this respect, e.g., Aho et al. (2006).

5. It has been shown that differences in innovative capabilities can explain in large part the diverging trends in economic growth in European regions (Fagerberg et al., 1997).
6. See, e.g., Lambooy (2004). In the USA the tradition of commercialisation of university knowledge is older than in the EU. Many universities have well-organised transfer organisations. They generate substantial revenue from licences. The amount of this revenue is determined to a large extent by the speed of commercialisation of patent-protected technology. Speed itself is determined by the resources available to the transfer organisation to identify potential licensees and by the involvement of the inventors in the adaptation to the needs of the licensee (Markman et al., 2005).
7. There is a second form of spin-off: that is, by students; they tend however to create more service-oriented firms that do not in general have the potential impact of the research-based spin-offs (Pinay et al., 2003). Other paths between university and enterprise can be identified but have not yet been thoroughly explored (e.g. Shinn and Lamy, 2006).
8. For that reason USOs that are done in the form of joint ventures with an existing company or with a venture capitalist tend to have better chances of a good performance than USOs that lack these links (Wright et al., 2004). Unfortunately both options have negative sides to them. The joint venture may tend to become dominated by the existing experienced company, making the rewards for the inventors for their efforts small. The market for venture capital that is interested in USOs is very opaque and there is in most places mismatch between demand and supply. Venture capitalists tend to shy away from companies that do not present sufficient capabilities in management and finance. This implies that an intermediary has to put together teams that can match the demands of these venture capitalists (Wright et al., 2006).
9. In presenting the cases of Cambridge (UK) and Leuven (Belgium), Wissema brings useful background information to the contributions of Adrian Healy (the case of the South East of England in Chapter 4), and the cases of Flanders described by Geert Steurs et al. (in Chapter 6) and Arnold Verbeek et al. (Chapter 3).
10. See in this respect also the results in universities that are not part of the top set in the EU, e.g. in Ireland (Dineen, 1995).
11. IDEA Consult is part of ECORYS Group, a multidisciplinary group of European research and consulting companies that includes NEI and Kolpron Consultants in the Netherlands and ECOTEC Research & Consulting in the UK.
12. For instance, the attractions of the scientific knowledge infrastructure in the UK explain how the technological efforts of non-UK businesses tend to be drawn relatively strongly to these regions (Cantwell and Iammarino, 2000).
13. Equating innovation with the development of new products results in a sort of 'quality ladder'. Firms, and consequently countries, that climb up the quality ladder can afford higher wages by offering higher quality. Important insights are given by the product cycle model and its corollaries the profit cycle, the innovation cycle and the manufacturing process cycle. These models describe the typical pattern of a product's lifespan: from R&D investment to success, and ultimate decline and replacement by newer products. Generally, the four phases are described as innovation, growth, maturity and decline. This approach highlights the different labour and capital needs related to the product in different phases, and the ebb and flow of innovation activity.
14. See, e.g., Malecki (1997) and Deiaco (1992).
15. Although one commonly distinguishes between the intra- and inter-firm patterns of adoption, the main drivers of the diffusion processes are common to both (Battisti and Stoneman, 2003).
16. The essential role of finance is very visible in the case of USOs; see the contribution of Wissema to this volume (Chapter 2) and chapter 7 of the book by Wright et al. (2007).
17. Other instruments have also been used, such as tax credits (see, e.g., Bloom et al., 2002). An overview and analysis of a number of financial schemes for innovation can be seen in Djarova et al. (2007).

18. See for instance CE/ECORYS et al. (2003). See, for the local character of knowledge, Saviotti (2007).
19. HEIs are easily identified as sources of human capital within a region. However, the decision to stay and work in the region after graduation is highly dependent on location factors such as the quality of living and employment opportunities (Simmie et al., 2002). In empirical studies, the attraction and retention rates of those trained and educated, which might act as a measure of the return on investment in education, are often ignored (De Gaudemar, 1996). There is as yet little knowledge on how students flow into the labour market and how this affects economic performance and regional innovation (Goddard, 1997a, 1997b; Besson and Montgomery, 1993).
20. For a general introduction, see, e.g., Camagni (1991) and Aydalot and Keeble (1988), and for special cases, Johannisson (1998) for Sweden and Ritsilä (1999) for Finland.
21. First, it takes skilled professionals to perform R&D tasks. A second – and often neglected – reason is that only trained practitioners can interpret new knowledge and adapt it for profitable exploitation. For these reasons, surveys among entrepreneurs invariably list the availability of qualified personnel within a region as one of the most crucial factors for success (e.g. Simmie et al., 2002; ECORYS–NEI, 2001).
22. See Cooke (2003) and Leydesdorff and Meyer (2006) and the articles referred to in the latter.
23. Untraded interdependencies (Storper, 1995) contain not only labour market, regional knowledge infrastructure, business climate, but also regional conventions, norms and values, and public or semi-public policies. When these untraded interdependencies are concentrated, Storper considers them to be of pivotal importance in the supply architecture of innovation and learning, and as key determinants of regional innovation.
24. The business climate can spur firms to be more innovative. Important aspects are of course competition, market structure and cooperation, as described above. But there is more. The prospect of profitable exploitation of the innovation is an incentive for the entrepreneur to innovate. The perspective of large market power, favourable technological opportunities, the availability of qualified labour and high demand expectations all have an unambiguous positive influence on innovation (Stadler, 1999).
25. From a government point of view, they distinguish the following three modes of technology transfer:

    - Grassroots RISs are characterised by local initiatives, diffuse funding (banks, local governments, chambers of commerce), applied, near-market research, low level of technological specialisation and local coordination.
    - Network RISs can be initiated at several levels: local, regional, federal or governmental. Consequently, funding is more likely to be agreed by banks, firms and government agencies. The research is mixed, aimed at both applied and 'pure' technology with flexible specialisation given the wide range of participants.
    - Dirigiste RISs are more animated from outside and above the region itself, initiated and funded typically by central governments. The research is rather basic or fundamental, to be used in large firms in or beyond the region in question. As it is state-run, the level of coordination is high and the level of specialisation is also likely to be high.

REFERENCES

Aho, E., J. Coruse, L. Georghiou and A. Subira (2006), *Creating an Innovative Europe*, Report of the independent expert group on R&D and innovation, Brussels.

Antonelli, C. (2006), 'The business governance of localized knowledge: an information economics approach for the economics of knowledge', *Industry and Innovation*, **13** (3), 227–61.
Arndt, O. and R. Sternberg (2000), 'Do manufacturing firms profit from intraregional innovation linkages? An empirically based answer', *European Planning Studies*, **8**, 465–85.
Aydalot, P. and D. Keeble (1988), *High Technology Industry and Innovative Environments*: *The European Experience*, London: Routledge.
Battisti, G. and P. Stoneman (2003), 'Inter and intra firm effects in the diffusion of new process technology', *Research Policy*, **32**, 1641–55.
Bergemann, D. and U. Hege (2005), 'The financing of innovation; learning and stopping', *The RAND Journal of Economics*, **36** (4), 719–52.
Besson, P. and E. Montgomery (1993), 'The effect of college and universities on local labour markets', *The Review of Economics and Statistics*, **75** (4), 753–61.
Bloom, N., R. Griffith and J. Van Reenen (2002), 'Do R&D tax credits work? Evidence for a panel of countries, 1979–1997', *Journal of Public Economics*, **85**, 1–31.
Braczyk, H.-J., P. Cooke and M. Heidenreich (1998), *Regional Innovation Systems*, London: UCL Press.
Camagni, R. (ed.) (1991), *Innovation Networks, Spatial Perspectives*, London: Belhaven Press.
Cantwell, J. and S. Iammarino (2000) 'Multinational corporations and the location of technological innovation in the UK regions', *Regional Studies*, **34** (4), 317–22.
Chang, Y. and M. Chen (2004), 'Comparing approaches to systems of innovation: the knowledge perspective', *Technology in Society*, **26**, 117–37.
CE/ECORYS et al. (2003), *Factors of Regional Competitiveness*, study commissioned by DG Regio.
Clarke, G.R.G. (2008), 'Has the internet increased exports from low and middle income countries?', *Information Economics and Policy*, **20**, 16–37.
Cooke, P. (2003), 'The governance of regional innovation systems', paper prepared for UNIDO conference on The Process of Innovation and Learning in Dynamic City-Regions in China, Cardiff.
Cooke, P. (2004), *Regional Innovation Systems: An Evolutionary Approach*, London: Routledge.
Cooke, P. and K. Morgan (1998), *The Associational Economy: Firms, Regions and Innovation*, Oxford: Oxford University Press.
Cooke, P., M.G. Uranga and G. Etxebarria (1997), 'Regional innovation systems: new models meeting knowledge economy demands', *Research Policy*, **26** (4/5), 475–91.
Cooke, P., P. Boekholt and F. Toedling (2000), *The Governance of Innovation in Europe: Regional Perspectives on Global Competitiveness*, London and New York: Pinter.
Debackere, C. and R. Vleugelers (2005), 'The role of academic technology transfer organizations in improving industry science links', *Research Policy*, **34**, 321–42.
De Gaudemar, J.-P. (1996), 'The higher education institutes as a regional actor: some introductory thoughts', paper presented at Centre for Educational Research and Innovation.
Deiaco, E. (1992), 'New views on innovative activity and technological performance: the Swedish Innovation Survey', *STI Review*, **11**, 35–62.

Dineen, D. (1995), 'The role of a university in regional economic development: a case study of the University of Limerick', *Industry and Higher Education*, **9** (3), 140–48.

Djarova, J. et al. (2007), *Creating Financial Incentives for Innovation in Bulgaria*, ECORYS Report.

ECORYS–NEI (2001), *International Benchmark of the Regional Investment Climate in North-western Europe*, Rotterdam.

EC (2003a), *Innovation Policy; Updating the Union's Approach in the Context of the Lisbon Strategy*, COM 2003; 112 final.

EC (2003) (DG Regio), 'Structural policies and European territories: Competitiveness, sustainable development and cohesion in Europe – From Lisbon to Gothenburg'. Brussels.

EC (2004), 'A new partnership for cohesion; convergence; competitiveness; cooperation', Third Report on Economic and Social Cohesion, Brussels.

EC (2007), 'Financing innovation and SMEs; sowing the seeds; main findings of four workshops', Brussels.

Etzkowitz, H. (1998), 'The norms of entrepreneurial science: cognitive effects of the new university–industry linkages', *Research Policy*, **27**, 823–33.

Etzkowitz, H. and L. Leydesdorff (1997), *Universities in the Global Knowledge Economy*, London: Pinter.

Fagerberg, J., B. Verspagen and M. Caniëls (1997), 'Technology, growth and unemployment across European regions', *Regional Studies*, **31** (5), 457–66.

Freeman, C. (1987), 'National systems of innovation: the case of Japan', in C. Freeman, *Technology Policy and Economic Performance*, London: Pinter Publishers.

Freeman, C. (1995), 'The national system of innovation in historical perspective', *Cambridge Journal of Economics*, **19**, 5–24.

Freeman, C. and L. Soete (1997), *The Economics of Industrial Innovation*, Cambridge, MA: MIT Press.

Furman, J., M.E. Porter and S. Stern (2002), 'The determinants of national innovative capacity', *Research Policy*, **31**, 899–933.

Goddard, J. (1997a), 'Universities and regional development: an overview', CURDS website: www.ncl.ac.uk.

Goddard, J. (1997b), 'The local and regional role of higher education: comments on the National Commission of Inquiry Report', CURDS website: www.ncl.ac.uk.

Grossman, G. and E. Helpman (1991), *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT Press.

Hall, B. (2005), 'The financing of innovation', mimeo, available from the Internet.

Hall, B. and J. Van Reenen (2000), 'How effective are fiscal incentives for R&D? A review of the evidence', *Research Policy*, **29**, 449–69.

Hollenstein, H. (2004), 'Determinants of the adoption of information and communication technologies (ICT)', *Structural Change and Economic Dynamics*, **15** (3), 315–42.

Horst, A. van der, A. Lejour and B. Straathof (2006), 'Innovation policy: Europe or the member states?', CPB document no. 132, The Hague.

Huntingford, J. and P. Frosini (2007) (eds), 'Knowledge and innovation for regional growth; policy recommendations based on European good practices', available from info@eriknetwork.net and from the website of the EU Commission.

Johannisson, B. (1998), 'Personal networks in emerging knowledge-based firms: spatial and functional patterns', *Entrepreneurship and Regional Development*, **10**, 297–312.

Jordan, A. and A. Schout (2006), *The Coordination of the European Union: Exploring the Capacities of Networked Governance*, Oxford: Oxford University Press.

Klette, T.J.J., Moen and Z. Griliches (2000), 'Do subsidies to commercial R&D reduce market failures? Micro econometric evaluation studies', *Research Policy*, **29**, 471–95.

Lambooy, J. (2004), 'The transmission of knowledge, emerging networks and the role of universities: an evolutionary approach', *European Planning Studies*, **12** (5), 643–57.

Leydesdorff, L. and M. Meyer (2006), 'Triple Helix indicators of knowledge-based innovation systems: introduction to the special issue', *Research Policy*, **35** (10), 1441–9.

Lööf, H. and A. Heshmati (2002), 'Knowledge capital and performance heterogeneity: a firm-level innovation study', *International Journal of Production Economics*, **76** (1), 61–85.

Lundvall, B.-A. (1988), 'Innovation as an interactive process: from user-producer interaction to the national system of innovation', in G. Dosi, C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), *Technology and Economic Theory*, London: Pinter Publishers, pp. 349–69.

Malecki, E. (1997), *Technology & Economic Development: The Dynamics of Local, Regional and National Competitiveness*, 2nd edn, Amsterdam: Addison Wesley.

Markman, G., P.T. Gianiodis, P.H. Phan and D. Balkin (2005), 'Innovation speed, transferring university technology to market', *Research Policy*, **34**, 1058–75.

Molle, W. (2006), *Economics of European Integration: Theory, Practice, Policy*, 5th edn, Aldershot: Ashgate.

Molle, W. (2007), *European Cohesion Policy*, London: Routledge.

Morgan, K. (1997), 'The learning region: institutions, innovation and regional renewal', *Regional Studies*, **31** (5), 491–503.

Morgan, K. and C. Nauwelaers (eds) (2003), *Regional Innovation Strategies: The Challenge for Less Favoured Regions*, Regional Development and Public Policy Series 24, London: RSA.

Nauwelaers, C. and R. Wintjes (eds) (2008), *Innovation Policy in Europe: Measurement and Strategy*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.

Nelson, R.R. (1988), 'Institutions supporting technical change in the United States', in G. Dosi, C. Freeman, R.R. Nelson, G. Silverberg and L. Soete (eds), *Technology and Economic Theory*, London: Pinter Publishers, pp. 312–29.

Nelson, R.R. (ed.) (1993), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.

NESTA (2007), 'Innovation policy in the modern world: five big challenges', Policy Briefing, National Endowment for Science Technology and the Arts.

OECD (1997a), *National Innovation Systems*, Paris: OECD.

OECD (1997b), *Industrial Competitiveness in the Knowledge-based Economy: The Role of Governments*, Paris: OECD.

OECD (2001), *The New Economy: Beyond the Hype*, Paris: OECD.

O'Shea, R., T.J. Allen, C. O'Gorman and F. Roche (2004), 'Universities and technology transfer: a review of academic entrepreneurship literature', *Irish Journal of Management*, **25** (2), 11–29.
Peterson, J. and M. Sharp (1998), *Technology policy in the European Union*, Basingstoke: Macmillan.
Pinay, F., B. Surlemont and F. Nlemvo (2003), 'Toward a typology of university spin-offs', *Small Business Economics*, **21** (4), 355–69.
Read, A. (2000), 'Determinants of successful organisational innovation: a review of current research', *Journal of Management Practice*, **3** (1), 95–119.
Ritsilä, J.J. (1999), 'Regional differences in environments for enterprises', *Entrepreneurship & Regional Development*, **11**, 187–202.
Rodríguez-Pose, A. and R. Crescenzi (2006), 'R&D, spillovers, innovation systems and the genesis of regional growth in Europe', BEER paper, 5, available from http://www.coleurop.be/eco/publications.htm.
Rubalcaba, L. (2007), *The New Service Economy*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.
Saviotti, P.P. (2007), 'On the dynamics of generation and utilization of knowledge: the local character of knowledge', *Structural Change and Economic Dynamics*, **18**, 387–408.
Schumpeter, J. (1934), *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest and the Business Cycle*, Cambridge, MA: Harvard University Press.
Shinn, T. and E. Lamy (2006), 'Paths of commercial knowledge: forms and consequences of university enterprise synergy in scientist-sponsored firms', *Research Policy*, **35**, 1465–76.
Simmie, J., J. Sennett, P. Wood and D. Hart (2002), 'Innovation in Europe: a tale of networks, knowledge and trade in five cities', *Regional Studies*, **36** (1), 47–64.
Spithoven, A. and P. Teirlinck (eds)(2005), *Beyond Borders: Internationalisation of R&D and Policy Implications for Small Open Economies*, Amsterdam: Elsevier.
Stadler, M. (1999), 'Demand pull and technology push effects in the quality ladder model', Tübinger Diskussionsbeitrag 172.
Storey, D.J. and B.S. Tether (1998), 'Public policy measures to support new technology-based firms in the European Union', *Research Policy*, **26**, 1037–57.
Storper, M. (1995), 'The resurgence of regional economies, ten years later: the region as nexus of untraded interdependencies', *European Urban and Regional Studies*, **2** (3), 191–221.
Vicente, M.R. and A.J. Lopez (2006), 'Patterns of ICT diffusion across the European Union', *Economic Letters*, **93**, 45–51.
Von Hippel, E. (1988), *The Sources of Innovation*, Oxford: Oxford University Press.
Wright, M., A. Vohara and A. Lockett (2004), 'The formation of high tech university spinouts: the role of joint ventures and venture capital investors', *Journal of Technology Transfer*, **29** (3/4), 287–310.
Wright, M., A. Lockett, B. Clarysse and M. Binks (2006), 'University spin-out companies and venture capital', *Research Policy*, **35**, 481–501.
Wright, M., B. Clarysse, P. Mustar and A. Lockett (2007), *Academic Entrepreneurship in Europe*, Cheltenham, UK and Northampton, MA, USA: Edward Elgar.