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Working Party on Small and Medium-Sized Enterprises and Entrepreneurship

NETWORKS, PARTNERSHIPS, CLUSTERS AND INTELLECTUAL PROPERTY RIGHTS: OPPORTUNITIES AND CHALLENGES FOR INNOVATIVE SMEs IN A GLOBAL ECONOMY

The OECD BOLOGNA PROCESS
2nd OECD Ministerial Conference on SMEs on "Promoting Entrepreneurship and Innnovative SMEs in a Global Economy -- Towards a more Responsible and Inclusive Globalisation", jointly organised by the OECD and the Turkish Ministry of Industry and Trade, ISTANBUL, Turkey, 3-5 June 2004

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FOREWORD

At the first OECD Conference of Ministers responsible for SMEs, hosted by the Italian government in Bologna, Italy, in June 2000, Ministers from nearly 50 member and non-member economies adopted the "Bologna Charter for SME Policies". They envisaged the Bologna Conference as the start of a policy dialogue among OECD Member countries and non-Member economies and that it would be followed up by a continuous monitoring of progress with the implementation of the Bologna Charter. This dialogue and monitoring have become known as the "OECD Bologna Process". The second OECD Conference of Ministers Responsible for SMEs, hosted by the Turkish Ministry for Industry and Trade, envisaged by Ministers at Bologna, provides an occasion to assess the impact on SMEs of new developments relating to globalisation.

This report is one of ten background reports prepared for the Istanbul Ministerial Conference, the theme of each of the ten reports being linked to a specific Workshop of the Ministerial Conference. Several earlier versions of the report were reviewed by the Working Party on SMEs and Entrepreneurship whose comments have been incorporated into the final version. Non member economies participating in the OECD Bologna Process have also had an opportunity to provide comments on an earlier version. This final report also sets out some policy messages and recommendations that have emerged from the preparatory work undertaken on these topics in both the OECD Working Party for SMEs and Entrepreneurship and in other OECD Committees. The wide variation in stages of economic development, institutional arrangements and political context across the economies participating in the Bologna Process, now more than 80, means that not all parts of specific policies and programmes are appropriate for all participants. The messages and recommendations outlined below provide material from which governments may choose to draw in promoting innovative SMEs in the global economy. In broad terms, these policy messages and recommendations elaborate on the themes developed in the Bologna Charter. Ministers will consider these and other recommendations in their deliberations at the Istanbul Conference.

The report was prepared by Jean Guinet of the OECD's Directorate for Science, Technology and Industry with a contribution in Part 3 ("IPRs and Innovation in SMEs") made by the World Intellectual Property Organisation, in particular by Esteban Burrone and Guriqbal Singh Jaiya of the Small and Medium-Sized Enterprises (SMEs) Division of WIPO (www.wipo.int/sme). Case studies were developed in cooperation with the Local Economic and Employment Development (LEED) Programme (by Alistair Nolan in cooperation with Stuart A. Rosenfeld, Linda Swanson, Johannes Traxler, Phil Psilos, Örjan Sölvell, and Andreu Llambrich).

This report is published on the responsibility of the Secretary-General of the OECD. Views expressed are those of the authors and do not necessarily reflect those of the Organisation or its member governments.

This and other background documents prepared for the 2nd OECD Conference of Ministers Responsible for SMEs may be downloaded free of charge from the following websites:

SME Unit website *:* http://www.oecd.org/sti/smes ;
Conference website: http://www.oecd-istanbul.sme2004.org

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EXECUTIVE SUMMARY

Even more than larger firms, SMEs need to access external sources of information, knowledge, know-how and technologies, in order to build their own innovative capability and to reach their markets. They can only partly secure such access through markets for goods, services, IPRs and human resources, and must also engage in networks, particularly those that nurture the tacit knowledge and other non-tradable competencies that are critical for pursuing innovation-based competitive strategies.

All firms must be connected to the most prolific sources of new knowledge and expertise, either directly or through multi-layered innovation networks that link the most research-intensive and/or innovative firms to others at regional, national and global levels. The report focuses on two critical nodes in such complex innovative networks: 1) public/private partnerships (PP/Ps) for research; and 2) geographically-concentrated clusters of innovative firms.

Appropriate networking strategies, barriers faced by SMEs in seizing networking and partnering opportunities, as well as appropriate responses by government vary greatly depending on the type of firms, especially their level of innovativeness and innovation mode. A "one-size-fits-all" approach is unwarranted, except for setting out the broad framework conditions (*e.g.* competition policy) that should allow market-friendly collaboration in the development and diffusion of new technologies.

For the vast majority of SMEs creating or reinforcing (mainly non-technological) innovation capacity and promoting their involvement in innovation networks are closely interrelated policy objectives. Government support should focus on early stages of network formation and operation, to correct information imperfections in order to raise awareness about networking opportunities and benefits, and facilitate the search for partners. Once networks are operational the main concern of governments should rather be to make sure that they remain open to new participants and do not distort markets.

Governments need to take a more pro-active approach to: 1) promote collaboration among SMEs involved in R&D-intensive innovation; 2) increase SME participation in public-private partnerships for research; and 3) close gaps within global innovation networks and strengthen linkages between the innovation and marketing processes.

Incentives to collaborative research that are provided within existing programmes to support business R&D favours innovation networks organised around large firms. Another, complementary, approach is to stimulate collaborative R&D among SMEs through specific project-based financial incentives.

PP/Ps for research are highly structured multi-actor networks that set a framework for the public and the private sectors to co-operate and join forces in areas where they have mutual or complementary interests but cannot act as efficiently alone. They are increasingly popular in research and development policy, because they are unique policy tools to fill certain gaps in innovation systems (*e.g.* the lack of interaction between science and industry), or increase the efficiency of government policy in addressing other market failures that affect innovation processes (*e.g.* sharing the cost and risk of pre-competitive research).

Access by small firms to PP/P programmes should remain mostly indirect through subcontracting with large firm. However there is room to increase the direct participation of SMEs in existing research networks. This should be achieved by improving the capability and incentives of SMEs to engage in PP/Ps, as well as by making adjustments in the organisation and governance of PP/Ps, rather than by regulatory "affirmative action."

Governments must cooperate in knitting a global web of innovation networks. This involves: (i) ensuring that their promotional programmes help national actors to access international networks; (ii) developing the international dimension of PP/Ps; (iii) interconnecting national and local hubs of technology transfer, linking national networks of SMEs with similar needs and complementary capabilities, building global networks of intermediary organisations, and coordinating national support programmes.

Clusters are localised agglomerations of firms working in related lines of business. Some clusters are characterised by large numbers of firms in which technological and organisational innovation is significant. Private and social returns on private and public investments associated with clusters can be high. In part this reflects the opportunity that physical/cultural proximity provides for high flows of information and from the close cooperation between firms and government in building tangible and intangible infrastructures for innovation and coping with market failures. The economic rationale for a cluster-based approach to innovation policy – analyzed in detail in the background material for the Bologna Ministerial Conference – is now well established. The focus should today be on a better understanding of the practice of cluster-based policy. The challenge is to extract universal but applicable lessons from diverse concrete experiences.

Five case studies have been prepared which include: a cluster in Montana, United States, comprised of manufacturers of prefabricated log homes; a cluster of biotechnology and life sciences enterprises in the Research Triangle Area of North Carolina, United States; an initiative in the automotive sector in Slovenia; the digital media and creative industries in Scotland, United Kingdom; and the system of Science, Technology and Enterprise in Valencia, Spain.

The cases were chosen for the variety of contexts and forms of intervention that they encompass, as well as for their focus on different aspects of innovation. The cases illustrate different approaches to clusters-based policy. For example, in Montana, it is seen that there was no overarching cluster or network strategy. Rather, a disparate set of interventions have been used that together reinforce the firms that make up the cluster. By contrast, in Scotland, an explicit network programme has been implemented and heavily resourced.

The case studies clearly point to the importance of inter-firm and inter-institutional networking. Indeed, in the creative industries cluster in Scotland, the firms themselves asserted that the most valuable function that Scottish Enterprise could perform would be to ensure a continued dialogue among the enterprises concerned. Initiatives also appear to be taking on considerable sophistication, with governments sometimes implementing detailed diagnostic work and adopting a broadly facilitatory role.

The conclusions emphasize a need for governments to address systemic or market failure constraints on the development of clusters. Public intervention should be catalytic and should not seek to create clusters *ab initio*. Stress is placed on working through partnerships and networks to achieve outcomes that the market will not. Such networking and partnership initiatives can also benefit from an international dimension. Again, the integration of national, regional and local initiatives and institutions is advocated. In addition, further examination of best practices and countries' experiences is suggested in such areas as the role of universities and knowledge-intensive services in cluster development; the regional

attractors of knowledge-intensive foreign direct investment, and the governance structures and means of evaluating cluster initiatives.

Key policy recommendations

- **Improve SMEs access to information about networking opportunities.** This will require co-operation among all stakeholders – including SME associations, public agencies and intermediary organisations – to correct deficiencies in existing sources of information. Strengthen international linkages between national and regional hubs of relevant information flows.
- **Increase the participation of SMEs in research networks and technology markets.** This includes greater SME involvement in existing (regional, national and global) public-private partnerships that connect science to innovation.
- **Support the emergence and maintenance of innovative clusters.** Help local actors implement the cluster strategies primarily through schemes to stimulate collaboration between public and private research institutions, improve the availability of market information and strengthen co-operation among firms, for instance in the fields of market intelligence, design and branding, and technological and human resource development.
- **Identify and promote best practice policies which support company innovation through cluster development.** Encourage exchange of experiences at national and international levels, especially regarding the governance structures and evaluation of cluster initiatives.
- **Enhance SME awareness and knowledge of all elements of the intellectual property system.** These include patents, trademarks, industrial designs, utility models, trade secrets, copyright and related rights, plant varieties and non-original databases. Strengthen the teaching of intellectual property rights at universities and training institutions for entrepreneurs, engineers, scientists, designers and business managers.
- **Strengthen the integration of intellectual property issues in programmes and policy initiatives aimed at fostering innovation in SMEs.** This will require greater interaction between intellectual property offices, SME support institutions, business associations, national, regional and local governments.
- **Facilitate the use of the intellectual property system by promoting the development of cost-effective mechanisms for application and for the resolution of intellectual property disputes.** These include opposition procedures, arbitration and mediation. Consider the development of the market for intellectual property insurance as a tool for reducing the costs of litigation for SMEs, identify existing barriers to this development and determine the scope and form of government intervention to remove them.

Intellectual Property Rights

The "knowledge economy" has brought about structural changes to the economies of OECD countries making it indispensable for companies and policy-makers to address new challenges. One of the most crucial challenges faced by firms is how to manage their existing and new knowledge effectively in order to make maximum benefit from the innovative and creative capacity of the firm. Intellectual property rights have emerged as key tools for managing innovation and resolving some of the "market failures" faced by innovating firms.

It is, therefore, increasingly important for entrepreneurs, inventors, researchers, SMEs and business consultants to have a good understanding of the IP system in order manage effectively a firm's intellectual assets. This is especially true for new technology-based firms (NTBFs) that are not only more numerous than in the past (especially in high-tech areas such as nanotechnology, biotechnology, software, and new materials) but also play an increasingly important role as innovation agents.

Evidence from a number of OECD countries show that SMEs, including NTBFs, are not always able to use the IP system effectively due to a number of obstacles including limited knowledge of the system, high costs and lack of adequate legal, business and technical support for developing a successful IP strategy as part of their business strategy.

Efforts to redress the situation have sought to address some of the specific challenges currently faced by entrepreneurs and SMEs. A number of experiences have brought about interesting results and should be studied in greater detail to understand the extent to which they may be replicated elsewhere. The report provides a number of examples of such good practice measures for enhancing a more effective use of the IP system by SMEs.

However, it is argued here that a more concerted effort is required from all institutions operating in the national innovation system to ensure that IP is adequately incorporated into the broader framework of support for entrepreneurs and SMEs. In doing so, institutions should take into consideration the main obstacles faced by entrepreneurs and SMEs not just in seeking grant/registration of IP rights but throughout the IP management cycle, including the commercial exploitation of IP rights, the use of patent databases, the valuation of IP assets and the enforcement of IP rights.

Networks, Partnerships, Clusters and Intellectual Property Rights: Opportunities and Challenges for Innovative SMEs in a Global Economy

INTRODUCTION

Innovation[1] is a key determinant of firm competitiveness in both fast growing high-tech sectors and more traditional sectors. The ability of most SMEs to survive, grow and generate new quality jobs increasingly depends on their capacity to put innovation at the core of their business strategy in order to harness benefits from technological change and the globalisation of markets for products and resources. In turn, small innovative firms, especially young ones, play a vital role in ensuring the vitality of regional and national innovation systems, and thus raising the growth potential of OECD economies, as demonstrated by the recent OECD Growth Study.

However, many SMEs have not yet developed a culture of innovation and those that do invest in innovation may still face obstacles in pursuing this strategy. Here lies a huge potential source of economic growth, job creation and social well being that governments can help realise through the improvement of framework conditions for innovation and more specific measures to correct market and systemic failures that impede or discourage innovation within small firms. Some countries have been more successful than others in promoting innovation in SMEs and various OECD bodies – particularly the Committee on Industry and Business Environment (CIBE), the Committee on Science and Technology Policy (CSTP) and the Local Economic and Employment Development (LEED) Programme – are active in identifying these best practices in different policy areas and promoting their diffusion. The Bologna Ministerial Conference on SMEs provided the first opportunity to take stock of national experiences and OECD-related assessments and gave impetus for a quicker and broader international learning of good practices.

The Bologna Charter on SME Policies recognises both the vital contribution of innovation to SME competitiveness and the central role played by SMEs in national innovation systems, and recommends that in developing SME policies, the following be considered:

- SME access to national and global innovation networks should be facilitated and their participation in public R&D programmes should be encouraged.
- Partnerships involving private actors, NGOs and different levels and sectors of public administration in local clusters and networking development strategies should be facilitated.
- The regulatory environment (*e.g.* competition policy, tax regimes, IPRs) should be improved to provide SMEs with greater incentives and capabilities to innovate.

In line with these recommendations, this report builds on recent OECD work and other sources. The first section, below, identifies and characterizes efficient policy instruments to integrate better SMEs in local, national and global innovation networks and research partnerships. The second section considers broader policy approaches to coordinate and enhance the efficiency of individual measures to support collaborative innovation strategies by SMEs (cluster-based policies). The final section examines one aspect of framework conditions for innovation that is critical for an efficient knowledge management in SMEs (Intellectual Property Rights regimes).

[1] Defined as the introduction of new or improved processes, products or services based on new scientific or technical knowledge and/or organisational know-how.

PART 1. NETWORKS AND PARTNERSHIPS

In a knowledge-based economy competitiveness is becoming more dependent upon the ability to apply new knowledge and technology in products and production processes. However, with growing competition and globalisation and the rapid advancement of knowledge, new technologies and innovative concepts have a wider variety of sources, most of them outside the direct control of firms that have become more specialised and focused on their core competencies. For complementary knowledge and know-how, they increasingly rely on collaborative arrangements, in addition to market-mediated relations (*e.g.* purchase of equipment, licensing of technology). Inter-firm collaboration within networks is now by far the most important channel of knowledge sharing and exchange. Interactions are also intensifying between firms and a number of other institutions involved in the innovation process: universities and other institutions of higher education, private and public research labs, providers of consultancy and technical services, regulatory bodies, etc.

Even more than larger firms, SMEs depend on external sources of information, knowledge, know-how and technologies, in order to build their own innovative capability and to reach their markets. Although different types of SMEs have different needs, all must be connected to the most prolific sources of new knowledge and expertise, either directly or through multi-layered networks that link highly innovative firms to others at regional, national and global levels.

Empirical studies have confirmed that collaborating firms are more innovative than non-collaborating ones, irrespective of their size (OECD, 2001*a*). But they have also shown that the propensity to engage in knowledge-based networks decreases with firm size. This is both a reflection and part of the explanation of the fact that the innovativeness of many SMEs is limited. Creating appropriate conditions and incentives for increased participation of SMEs in innovative networks is thus a key policy challenge. This chapter addresses there basic questions: What are the key benefits of networking/partnerships for SMEs? What barriers may prevent SMEs to harness such benefits? How can governments remove these obstacles, with a focus on best practice policies to facilitate SMEs involvement in public-private partnerships for research?

Innovative networks – economics, features and key benefits for SMEs

A network is an organisational form of economic activities that may allow firms to cope with market failures that hierarchy (*i.e.* internalisation of transactions through acquisition, mergers, etc.) cannot correct. However collaboration between firms can be as well a source of market imperfections and should not therefore be allowed or promoted without a careful assessment of its economic rationale. For a firm, the comparative advantage of networking over market transactions and internalisation depends on two main attributes of the assets to be used in its research, production and marketing processes: their nature and diversity, and the feasibility and cost of producing them or buying them on markets, relative to what can be appropriated through product market prices. The rise of an innovation-driven growth model seems to have enhanced the value of networking by increasing both the specialisation of production factors and the complexity of interdependent production processes that take place in increasingly uncertain business environments (Box 1).

Box 1. The economics of networking

Markets, hierarchies and networks have for long co-existed as complementary organisational forms of economic activities. But their relative importance may change with the dominant techno-economic paradigm, depending on its characteristics regarding: the degree of specificity of resources and knowledge required by interdependent activities, and the level of transaction costs incurred in managing and coordinating such activities, and the nature of innovation processes.

Theoretical advances in the understanding of the micro and macro drivers of innovation-led growth explain why the rise of the comparative advantage of networks over markets and hierarchies seems to have increased in the last decade:

- *New growth theory* stresses the importance of increasing returns on investment in new technologies and human capital, based on an exponential increase of both the volume and diversity of both codified and tacit knowledge.
- *Evolutionary and industrial economics* demonstrates that this accumulation process is non-linear (involving interactions between the different stages of research and innovation) and shaped by the interplay of market and non-market organisations and by various institutions (social norms, regulations, etc.).
- *Institutional economics* stresses the importance of organisational innovation within firms and government in the design and co-ordination of institutions and procedures involved in handling more complex interdependencies, as growth leads to the increasing specialisation of tasks and productive tools.

Sociology of innovation stresses the role of "trust" in coping with uncertainty and in avoiding the escalation of transaction costs that result from increased specialisation, and the role of non-monetary incentives and barter trade within innovation networks in boosting creativity.

Although collaboration remains a more widespread phenomenon than innovation (Box 2), the accelerated development and diversification of innovative networks is a key feature of ongoing structural changes in the micro-economics foundations of economic growth, for two reasons. First, networking is among the new forms of organisational models, managerial practices and working methods that are prerequisites for technological innovation since it allows firms to cope with the increasing interdisciplinary nature at the core of today's technical change, to reduce the risks of investing in novelty, and to link innovation to demand. Second, networking plays a greater role in its own right, as an organisational innovation which is a source of value-added and flexibility, especially in the service sector.

Innovative networks take many different shapes (Figure 2) and can be distinguished according to the following main characteristics:

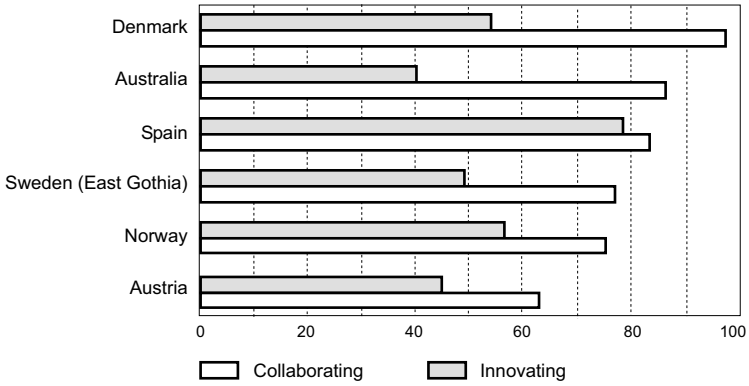
- *Type and variety of partners.* The networks connecting individuals and organisations in functional areas (*e.g.* research, production, logistics or marketing) are gaining in importance relative to those that link partners in a more traditional vertical chain. Another general trend is the rapid development of networks comprising a wide variety of actors, such as suppliers, users, scientific organisations, business-oriented services, public bodies, etc. Partnerships between small firms, large firms and public research organisations, are gaining in importance because they are efficient ways of refining the division of labour within innovation systems to the benefit of all.

- *Innovation mode.* Many networks have still a strong sectoral focus but others, which span across industries and technological fields, are becoming more frequent.

- *Geographic scope.* Networks can be local, regional, national, international or global in scope, depending on the type of partners and the predominant innovation mode. The geographical boundaries of networks are permeable and change over time since networks with a strong local focus and based on close personal relations are supplemented rather than replaced by international networks and electronic interaction.

Box 2. Collaboration and innovation

Figure 1. Percentage of firms collaborating and innovating in selected countries (2000 or latest year available)



Source: OECD (2001a), based on a special DISKO survey.

Table 1. Innovation and collaboration in Australian manufacturing sectors (1999)

Industry sector	% of which innovating	% of which collaborating
Wood, paper	17	88
Printing, publishing	20	73
Metal products	32	88
Textiles, clothing, footwear	37	65
Food, beverages, tobacco	43	89
Other manufacturing	44	80
Petroleum, coal, chemical	46	89
Non-metallic minerals	50	86
Machinery, equipment	53	85

Source: Australian DISKO survey.

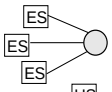
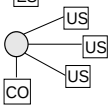
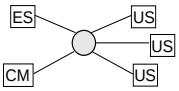
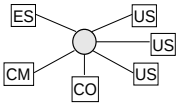
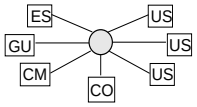
- *Organisation and relations between partners – from loose networks to structured multi-actor partnerships.* Network relationships vary considerably, ranging from highly informal, flexible and trust-based relations to more formalised and stable arrangements, such as partnerships. However, behind every formal network (research co-operations, joint ventures, etc.) there are various informal networks which give it life and sustainability.

The following benefits of networking have been identified by recent theoretical and empirical work (OECD, 2001*a*): [2]

- *Increased scale and scope of activities*. The results of collaboration may be applicable to each firm's market and thus serve to expand its customer base. A firm's capability may be considerably extended if it can achieve synergy between different technological competencies and between technological and organisational innovation.

[2] Although the empirical findings confirm the reality of the benefits that the theory suggests (e.g. increased innovativeness of network partners), the evidence is not one-sided. Networking is not the panacea to meet the challenges of an innovation-driven economic development. In adverse environments that unduly reduce the efficiency of alternative organisational models, it can have undesirable consequences, e.g. reduced incentive to conduct in-house research, technological lock-in and distortion of market competition.

Figure 2. Types of innovative networks

Type of network (Survey of 8 European countries[1])	% share
Weak or no network linkages	12.9
Equipment supplier (ES) dominated networks 	14.4
Marketing-oriented networks: users (US) and competitors (CO) 	16.0
Marketing-oriented networks: equipment & component (CM) suppliers and users 	15.8
Marketing-oriented networks: equipment & component suppliers, users and competitors 	21.9
Complete innovation networks, including government laboratory and university (GU) 	19.1

1. Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway.

Source: OECD (1998).

- *Shared costs and risks*. The costs associated with innovations have risen rapidly and are now often beyond the means of any single firm. The high costs and risks of innovation can be shared under a collaboration agreement.
- *Improved ability to deal with complexity.* Many key technological developments are complex and draw on a wide range of scientific and commercial knowledge. This reinforces the need for co-operation with participants in different fields of expertise. Networks help firm to deal with the complexity of multiple sources and forms of technology.
- *Enhanced learning.* Owing to continuous and rapid market and technological changes, firms need to be adaptive through continuous learning. Collaboration enhances such learning about new technologies, prospective technologies and ways in technological change may affect the existing business. It can also teach companies to change their organisational approach.
- *Flexibility and efficiency in knowledge management.* Much knowledge is tacit and firm-specific and therefore difficult to transfer through market mechanisms. Networks facilitate exchange of all sorts of knowledge on the basis of mutual trust, including between large and small firms.
- *Speed.* Speed is often essential for taking advantage of emerging opportunities. A network can put together a package of resources to seize opportunities in a customised response that, in its flexibility and scope, may be beyond the capacity of single firm.
- *Resilience.* The speed of change in international markets and science and technology, along with the greater diversity and specialisation of knowledge, create uncertain and rapidly changing environments for firms. In stable environments it may be sufficient for firms to engage in exclusive relationships with only a few partners. Firms in dynamic environments need to explore continuously multiple contacts and even accept a certain degree of redundancy in their external linkages, in order to cope with their evolving but largely unpredictable knowledge needs.

Box 3. Innovation in small and large firms

Figure 3. Share of business R&D by size class
(2001, %)

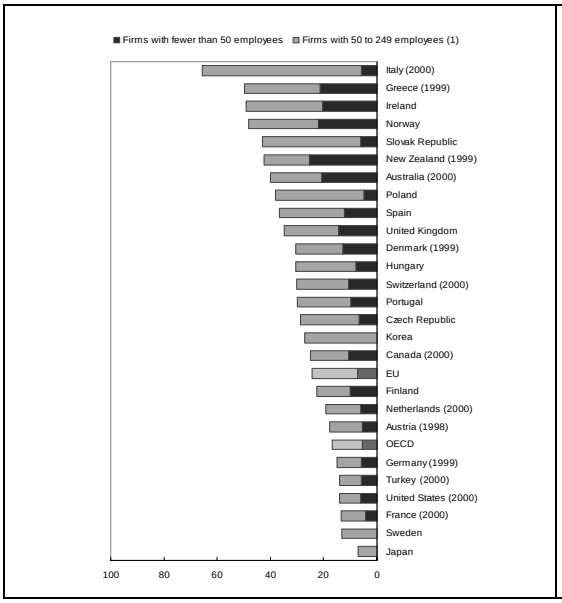


Figure 4. Share of innovative firms by size class
(period 1998-2000, %)

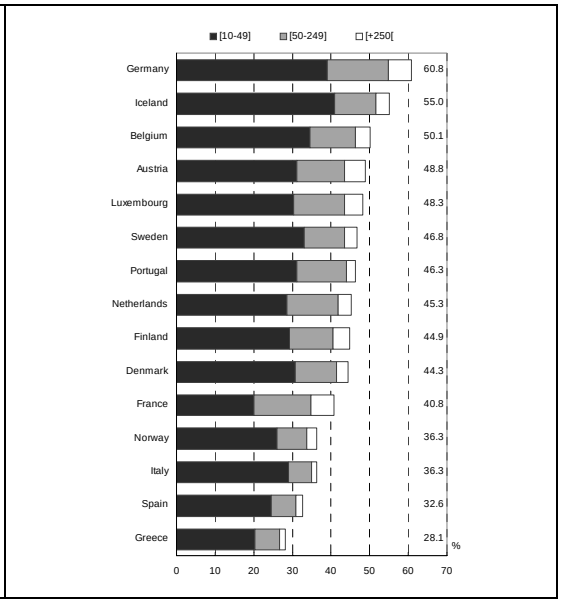
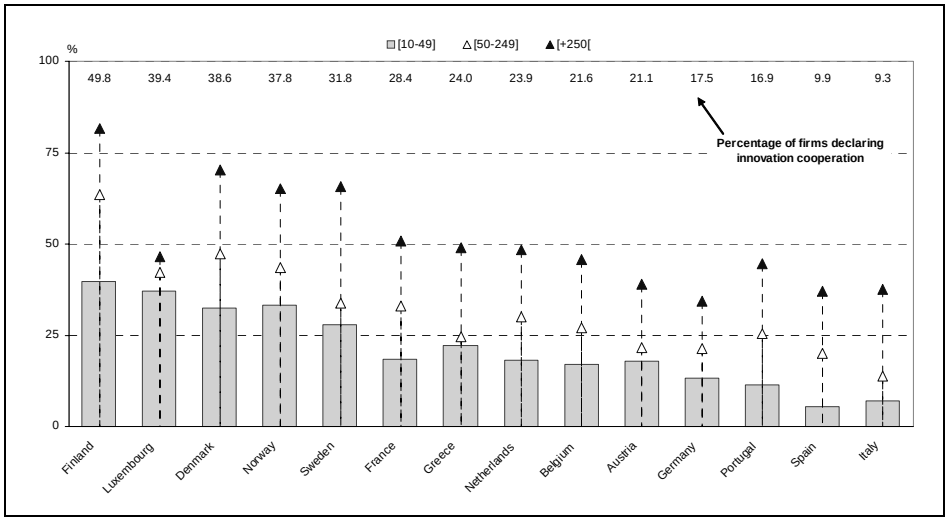


Figure 5. Innovation and co-operation in small and large firms
Share of firms declaring innovative cooperation arrangements, by size class
(period 1998-2000, %)



Source: OECD; EUROSTAT (CIS3).

Despite the fact that these benefits accrue to all collaborative firms, irrespective of their size and activity, empirical studies demonstrate that: (i) the propensity to engage in innovative networks, as well as the density and diversity of external linkages, decreases with firm size (Figure 5); and (ii) firm size also affects how collaboration influences the in-house innovation process. Whereas for larger firms collaboration leads to increased spending on innovation, for smaller innovative firms collaboration is often a substitute instead of a trigger for internal activities. This suggests that many SMEs face both internal and external obstacles to seizing networking opportunities.

Barriers faced by SMEs in seizing networking and partnering opportunities

Compared to large firms SMEs tend to have more limited financial and human resources, less ready access to information, and shorter time horizons. In addition, they are generally more risk-averse and reluctant to engage outside help, except for very specific short-term needs. However when assessing the consequences for networking behaviour, one should avoid generalisation since SMEs form a very diverse population.

The first reason why the majority of SMEs do not take full advantage of networking opportunities is their lack of motivation to do so. Many firms do not collaborate simply because they do not innovate, and reciprocally. There is ample evidence that the innovation capacities of many SMEs are limited (Figure 4). They are caught in a "low capability trap":

- Until a firm has learnt something, it cannot properly specify what it needs to learn. Organisational inadequacies, unavailability of key information, and/or deficiencies in managerial skills prevent sound self-diagnosis of needs and reduce the perceived value of technological or organisational innovation, including networking.
- More generally, many firms lack certain competencies to manage innovation, especially when it involves developing and mastering external linkages.

SMEs that do innovate vary considerably in their level of competence. In broad terms, one can distinguish four levels of innovativeness (OECD, 1998, 2002*a*):

- Level 1 – The static firm innovates from time to time, but may have a stable market position under existing conditions.
- Level 2 – The innovating firm has the capability to manage a continuous innovation process in a stable competitive and technological environment.
- Level 3 – The learning firm has, in addition, the capability to adapt to a changing environment.
- Level 4 – The self-regenerating firm is able to use its core technological capabilities to reposition itself on different markets and/or create new ones.

Firms at level 1 are likely to collaborate mainly for marketing purposes or as a substitute for in-house investment in knowledge. For them, engaging in innovative networks is often a prerequisite for progressing to level 2 and above, but they face both internal (limited managerial and absorptive capacity) and external obstacles to do so. SMEs with higher levels of innovativeness have stronger incentives to develop linkages with other firms and knowledge institutions, but they often experience difficulties in devising and implementing their networking strategy. These difficulties, which generally increase with the depth and breadth of the network, are due to:

- The relatively high input in senior management resources required for initiating and sustaining a participation in a cooperative venture;
- The need to commit resources for a long period; and
- The difficulty of gaining enough influence within a network to justify such investment and commitment, given the pivotal role of large firms within high-tech, and especially science-based innovation networks.

Barriers to technological entrepreneurship magnify the negative impact of other obstacles to networking, since new technology-based firms (NTBFs)[3] perform a special function within and across innovation networks. They are bridging institutions that close the information gap between large knowledge organisations and firms in traditional industries. In addition to serving different markets, NTBFs are complementary to large firms in their way of interacting with other actors of innovation systems. NTBFs often depend on close relationships with large firms to secure access to managerial, financial and technical resources and marketing channels. Partnering with NTBFs, or informal privileged relationships with spin-out firms, gives large firms the possibility to reconcile the need to explore other opportunities at low risk and to offer value-added characteristics to their products, without straying from their core production. These benefits are enhanced by globalisation since spin-offs or contractual arrangements with NTBFs can offer a viable alternative to direct investment or acquisition as an internationalisation strategy.

Disincentives and obstacles to networking by SMEs translate into three types of bottlenecks/distortions in multi-layered regional, national and global research and innovation networks:

- Lack of collaboration between SMEs which reduces the circulation and exchange of information and tacit knowledge, to the detriment of non-technological innovation, for instance in the fields of market intelligence, design and branding, and human resource development.
- Insufficient interaction between high-tech firms and others, to the detriment of technological innovation and technology diffusion, especially in science-based fields.
- Geographical imbalances in international co-operation patterns, including the under-development of “North-South” and “South-South” co-operation.

Government measures to facilitate participation of SMEs in innovation networks and research partnerships – Rationale, trends and selected good practices

The existence and nature of these bottlenecks/distortions provide strong justifications as well as directions for government intervention to facilitate participation of SMEs in innovative networks. Such facilitation requires a broad approach which takes into account that promoting technological entrepreneurship, building the innovation capacity of SMEs and promoting their involvement in innovation networks are closely interrelated objectives. This chapter focuses on the latter.

Most governments have become increasingly aware of the contribution of market-friendly co-operative networks to innovation-led growth and of the fact that their spontaneous development may encounter obstacles, especially for smaller firms. They have developed various policies aimed at facilitating the creation and efficient functioning of inter-firm and wider innovation networks. Programmes and initiatives which explicitly address networking are a rather new phenomenon. In fact, economic research does not yet provide policy makers with clear-cut conclusions about: (i) the conditions under which network arrangements prove more efficient than alternative organisational solutions; (ii) the types of

[3] NTBFs can be spin-outs from large firms, spin-offs from public research or creation *ex nihilo*. They account for between 1 and 3 per cent of all firms. This is what suggests a simple model of enterprise demography. Based on average start-up rates (between 5 and 20 per cent per year) and an average survival distribution of new firms, such models predicts that, of all SMEs, between 10 and 30 per cent could be categorised as new firms (of an age below five years), among which between 30 and 60 per cent can be characterised as innovative, among which, only a certain share, say 10 per cent, is technology-based.

market "failures" that typically occur when setting up and operating networks;[4] and (iii) which of these failures can be corrected by government. Policy making in this area is thus to a large extent experimental which makes international learning-by-doing vitally important.

Public policy may address market failures at different stages of the networking process through SME-specific or less targeted measures (Table 2):

- Raising awareness of networking opportunities and helping search for partners.
- Organising, financing and operating networks.
- Interfacing scientific and innovation networks through public-private partnerships (PP/Ps)
- Creating international linkages and building global networks.

Table 2. A typology of measures to support innovative networks, with selected examples

<table>
<tr><td rowspan="2"></td><td colspan="2">Generic</td><td colspan="3">Targeted at industry-science relationships (PP/Ps for research)</td></tr>
<tr><td>Awareness of networking opportunities and search for partners</td><td>Active support to the organisation and operation of networks</td><td>Financial and institutional support</td><td>Regulatory approach</td><td>Tax incentives</td></tr>
<tr><td rowspan="4">SME-specific</td><td rowspan="2">Innovation Portal (Canada)
Inno-NET Portal (Korea)</td><td>Co-operative research (CRAFT) (EU)</td><td colspan="3" rowspan="2"></td></tr>
<tr><td colspan="2">Pro-Inno (Germany)</td></tr>
<tr><td colspan="2" rowspan="2">Innovation Relay Centres (most European countries -- plus a pan-European IRC network)
INSME</td><td>TEFT (Norway)</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">SBIR / STTR (United States)</td></tr>
<tr><td rowspan="2">Non SME-specific</td><td>CORDIS Technology Marketplace (EU)</td><td colspan="2">Centre of Expertise & Cluster programmes (Finland)</td><td>Target (15 %) for SME involvement in the 6th FP (EU)</td><td>Tax deduction on collaborative R&D (Denmark)</td></tr>
<tr><td colspan="2"></td><td>Innovation Consortia (Denmark)
CRCs (Australia)
K centres (Austria)</td><td colspan="2"></td></tr>
</table>

Source: OECD.

Raising awareness of networking opportunities and helping the search for partners

Market failures are generally more severe in the early stages of network formation and operation (search, setting-up, trust formation, etc.). This justifies measures to correct relevant information imperfections. Such measures can be targeted at networking, but generally they are one element of information platforms with broader scope (Box 4). Strategis and Innovation Portal in Canada, MEP in the United States, Small Business Service and Business Link in the United Kingdom, and Inno-NET Portal in Korea are good examples of government initiatives that take advantage of new information technologies

[4] The basic rationale for government involvement is that the costs of setting up and running a network (finding the right partners, negotiating, creating behavioural rules for co-operation and building the necessary shared resources) may exceed the private benefits from network formation, due to network externalities that encourage free riding.

for improving the access of SMEs to information on networking opportunities and to strengthen incentives to exploit them.

Box 4. Platforms to help SMEs access a national pool of expertise and services

MEP (United States)

The Manufacturing Extension Partnership (MEP) is a nationwide network of not-for-profit centers in over 400 locations in all 50 States and Puerto Rico, whose purpose is to provide small and medium sized manufacturers with the help they need to succeed, including in the field of. The centers are linked together through the Department of Commerce's National Institute of Standards and Technology. Centers are funded by federal, state, local and private resources. Each center works directly with area manufacturers to provide expertise and services tailored to their most critical needs, which range from process improvements and worker training to product development and innovation management. Since its beginning MEP has assisted over 149 000 firms.

Small Business Service and Business Link (United Kingdom)

The Small Business Service (SBS) was launched in April 2000 to provide a single organisation in government dedicated to helping small firms and representing them within Government. The main objectives of the SBS are to: provide business support services to enhance the performance of small businesses with growth potential; promote enterprise across society and particularly in under-represented and disadvantaged groups; achieve the highest standards of service delivery. SBS also runs national services to help small firms such as the Benchmarking service, the Loan Guarantee Scheme, and Smart grants.

The Business Link network provides information, advice and access to experts on all issues relating to running a business. The equivalent of Business Link in Scotland is Scottish Enterprise and Local Enterprise Councils (LECs). In Wales, it is Business Connect Wales Ltd and in Northern Ireland it is Economic Development Partnerships.

Financial incentives to networking

Policies which attempt to promote (mainly non-technological) innovation activities of a majority of SMEs through support to early stages of networking may not be sufficient to overcome specific barriers faced by the sub-set of SMEs involved in R&D-intensive innovation. One answer is to add incentives to collaborative research in existing programmes to support business R&D, but this favours mostly innovation networks organised around large firms. Another, complementary, approach is to catalyse collaborative R&D among SMEs through project-based financial incentives (*e.g.* one of the objectives of Pro-Inno in Germany – Box 5).

Box 5. Project-based support to research networks – Pro-Inno (Germany)

Pro-Inno supports R&D co-operation projects by an SME (a) with firms, (b) with public or private research organisations, or (c) in the way of external research contract to research institutions. Eligible firms are SMEs with less than 250 employees. Eligible R&D projects must have a high technological risk, be oriented towards significantly new products, processes or services, and must sustainably increase the innovation level of the firm. R&D projects should either (a) represent the first way into R&D for an SME, the entrance into a new field of technology or the use of a new combination of technologies, or (b) increase co-operation experiences in the field of R&D, co-operation with foreign partners or co-operation with more than one partner.

Box 6. The increased use of public-private partnerships (PP/Ps) as a S&T policy tool

Table 3. Budget for PP/Ps in the Netherlands (2003)

PP/P programmes	€ million
STW Technology Foundation	42.788
Innovation-Oriented Research Programmes (IOP)	13.430
Organisation for Applied Scientific Research (TNO)	28.149
Leading Technology Institutes (LTI)	28.951
Technological Partnership scheme (TS)	62.132
Economy, Ecology and Technology programme (EET)	33.000
The Netherlands Genomics Initiative	11.345
ACTS	2.333
Total PP/P programmes	**222.128**
Total S&T budget	3 520.494
Share of PP/P programmes in total S&T budget for 2003	**6.3%**

Source: The Netherlands Ministry of Economic Affairs.

Table 4. Budget for PP/Ps in Australia (2002-03)

PP/P programmes	AUS$ million
Co-operative Research Centres Program	148.6
Innovation Investment Fund	26.0
Pre-Seed Program	6.0
Rural R&D Corporation	194.4
Australian Research Council (ARC) Linkage Grants and Industry Fellowships	76.7
Total PP/P programmes	**451.7**
Total S&T budget	4989.0
Share of PP/P programmes in total S&T budget	**9.1 %**

Source: Australian Department of Education, Science and Training.

Table 5. Share of PP/Ps in competitive funding of research in France

€ million	1998	1999	2000	2001	2002
PP/Ps (RRIT)	15.2	50.6	66.3	86.9	80.2
Other competitive funding	26.0	20.4	21.5	22.7	23.0
Total	41.2	71.0	87.8	109.6	103.2
PP/Ps in %	**37%**	**71%**	**76%**	**79%**	**78%**

Source: French Ministry of Research.

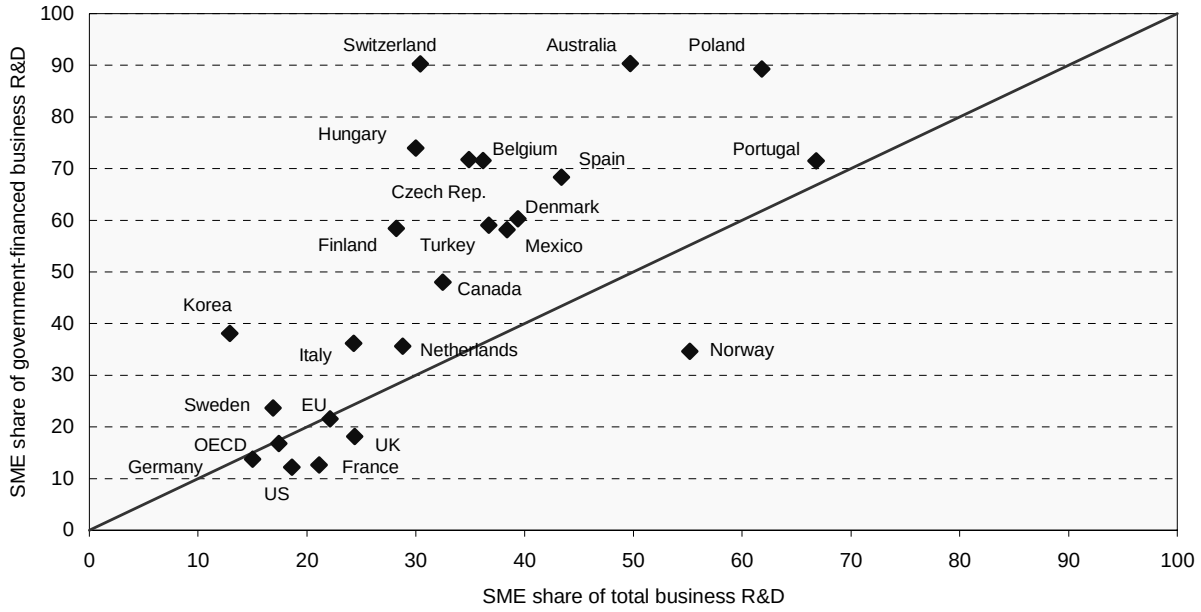
Box 7. The increased use of PP/Ps boost SME share of S&T budget

Table 6. Share of SMEs in the financing of 13 French Public/Private Research Networks
(2001, million Euros, %)

Type of recipient	Life sciences (1)		Energy, transport, environment, natural resources (2)		Information and communication technologies (3)		Space and aeronautics		Total	
	€	%	€	%	€	%	€	%	€	%
SMEs (4)	**11.39**	**43**	**4.34**	**25**	**7.34**	**19**	**1.78**	**35**	**24.84**	**29**
Large firms (5)	0.37	1	1.71	10	6.76	18	0.11	2	8.95	10
Public Research labs	11.15	42	6.60	38	12.55	33	1.38	27	31.67	36
Higher education	1.43	5	2.62	15	7.08	19	0.75	15	11.88	14
Engineering schools	0.93	3	0.83	5	2.88	8	0.60	12	5.25	6
Others	1.39	5	1.32	8	1.09	3	0.46	9	4.27	5
Total	26.65	100	17.43	100	37.69	100	5.09	100	86.86	100

1. RNTS, GenHomme, Génoplante, RARE.
2. PREDIT, Pile à combustible, Matériaux, Génie civil, Eau et environnement, Pollution accidentelle.
3. RNRT, RNTL, RMNT.
4. Enterprises with less than 500 employees.
Source: French Ministry of Research.

Figure 6. SME R&D versus government funding of SMEs (%)



Source: OECD.

Encouraging SME participation in Public-Private Partnerships (PP/Ps) for research

PP/Ps for research sets a framework for the public and the private sectors to join forces in areas where they have complementary interests but cannot act as efficiently alone. Traditional in building physical infrastructures, they are increasingly popular in research and development policy (Box 6), because they are unique policy tools to fill certain gaps in innovation systems (*e.g.* the lack of interaction between

industry and public research at a time when innovation is increasingly rooted in science), or increase the efficiency of government policy in addressing other market failures that affect innovation processes (*e.g.* sharing the cost and risk of pre-competitive research) (OECD, 2001*b*, 2002*b*). Increased participation of SMEs in PP/Ps is essential for stimulating technological entrepreneurship, ensuring that highly innovative small firms have access to the most fertile sources of knowledge, and linking science-based innovation networks to less R&D-intensive ones.

The greater priority given to the promotion of interaction and collaboration between public sector institutions and the private sector in S&T policy may induce by itself an increased participation of SMEs in publicly-supported R&D projects (Box 7). This accentuates the "revealed preference" of government-financed business R&D for small firms that can be observed in a majority of countries, and attenuates the "bias against SMEs" in others (Figure 6). France exemplifies the latter (Tables 5 and 6). The launch in the late 1990s of the National Networks of Research and Innovation (RRIT), which organise the co-operation of public and private research in 18 technological areas, had two major impacts. First, it boosted the involvement of independent SMEs in research areas so far dominated by large firms and their sub-contactors (*e.g.* in transport and telecommunications, where RRIT replaced less SME-friendly previous approaches, the so-called "grands programmes"). Second, it created new opportunities for science-industry partnerships in areas (*e.g.* life sciences, multimedia) where new and existing small firms are key actors at every stage of the research and innovation processes.

However, imposing collaboration with other firms as an eligibility condition in PP/Ps may not be sufficient to guarantee a satisfactory degree of SME involvement. The weak presence of SMEs at the interface between science and innovation systems remains an issue in almost all countries, even in those that have comparatively the longest successful experience in PP/Ps. For example, in Australia, the guidelines for the latest selection round of Co-operative Research Centres (CRCs) stated that the government wished to see opportunities for SMEs to participate enhanced.[5] Several approaches can be considered and possibly combined to improve the situation.

Laying the ground

The lack of social networks on which to build more formal partnerships when opportunities arise is a key problem. Cultural barriers between SMEs and the scientific communities are high. Only inter-personal relationships will bridge the two worlds when they are profoundly separated. Government can help through measures focusing on human resources. An example of good practice is the Business Fellowship scheme in the United Kingdom (Box 8).

Box 8. Strengthening links between universities and SMEs – Business Fellowship Scheme (UK)

Launched in 2001, the Fellowship scheme focuses on recognising and developing creative activities carried out within universities to build their response to the needs of business, across the full range of their academic activity. It does so by identifying mainstream academics as Business Fellows, who can raise the academic credibility of the institution's interactions with business, and catalyse further activities. To enable fellows to spend part of his or her time advising companies on technical or research problems and so helping to stimulate wider ranging HE-business networks and clusters.

[5] The Minister stated: *"One of the strengths of the CRC Program has been its flexibility in the range of participants and operating structure of each individual CRC. I would like applicants to think innovatively about how they can better involve the many SMEs that make up an integral part of Australia's industrial structure. It is important that Centres develop linkages with SMEs to facilitate technology transfer. I would also expect to see an increase in SME spin-offs coming out of the Program in the future."*

Enlarging the pool of motivated and competent SMES through conducive regulation and incentives

All measures to increase the propensity of existing SMEs to engage in R-D-intensive activities or encourage the creation of new technology-based firms contribute to this objective, but not always as effectively as one would hope. More targeted approaches whereby capacity building, entrepreneurship and collaboration with public research are promoted together may exert greater leverage. An emblematic example of such approaches is the SBIR programme in the United States (Box 9). In 1992, it was complemented by the STTR programme which requires recipients to have cooperative relations with universities or national labs and hence gave to SBIR a stronger PP/P content. Recent evaluations are quite positive, showing that recipients exhibit superior performance (higher likelihood of survival, higher growth rates) and that SBIR fosters entrepreneurial behaviour by inducing scientists to start firms and encouraging those outside the programme through a demonstration effect. However they also point to weaknesses, especially the insufficient coordination with measures to help the commercialisation of supported research (*e.g.* provision of venture capital through SBICs). In national contexts where imposing a regulatory burden on public research would not seem desirable or feasible, a softer solution may be to grant conditional financial or fiscal incentives. For example, in Sweden, VINST (research co-operation for smaller high-tech companies) stimulates smaller high-tech companies to co-operate with researchers at universities and research institutes in the development of new products. In Denmark, a tax deduction on collaborative R&D has been introduced recently.

Box 9. Increasing cooperation between SMEs and public research through regulatory targets

Hard target: The SBIR/STTR programmes (United States)

The Small Business Innovation Research (SBIR) programme was established under the Small Business Innovation Development Act of 1982. It is a set-aside program (2.5% of a public agency's extramural budget) for domestic SMEs to engage in R&D that has the potential for commercialisation. Each year, ten federal departments and agencies are required by SBIR to reserve a portion of their R&D funds for award to small business.

The Small Business Technology Transfer Programme (STTR) was subsequently introduced to expand funding opportunities to include the joint ventures between SMEs and small non-profit research institutions. Each year, five federal departments and agencies are required by STTR to reserve a portion of their R&D funds for award to small business/nonprofit research institution partnerships.

Soft target: SME participation in the European Sixth Framework Programme (EU)

Small and medium sized enterprise (SME) participation in selected Sixth Framework Programme (FP6) proposals from the first call in the priority thematic areas corresponds to 13 percent of the available budget. The target for SME involvement in the programme set by the Commission is 15 percent.

Fine tuning PP/P programmes

Co-operative research ventures involving public and private actors, as well as small and larger firms, are fragile constructions which must last long to hold fruits. They are based on trust and their success depend on the existence fairly shared sustained mutual benefits. Efficient PP/Ps build on bottom-up initiatives, stress competence as the main criteria for selecting participants, and have only light top-down steering processes. Their integrity could easily be jeopardised by top-down interferences such as "affirmative action" regarding the nature and identity of participants. SME participation should therefore be promoted in more subtle ways.

The accumulated experience with successful programmes[6] suggests that there are three main roads to improvement. The first, most obvious, one consists of ensuring that the portfolio of PP/Ps (*i.e.* the

[6] The OECD has recently conducted detailed evaluations of four national PP/P programmes: CRCs (Australia); Kplus and Kind/Knet centres (Austria); RRIT (France); and LTIs (Netherlands) (OECD, 2003*ab*, 2004*ab*).

set of individual cooperative ventures supported under a PP/P programme) gives sufficient space to the technological areas where smaller organisations are main actors. The second consists of lowering entry barriers by creating mechanisms which allow easy and inexpensive access to the PP/P through, for example, industry associates programmes. Typically, such programmes allow SMEs to become associated with a PP/P at a nominal cost which then provides them preferential access to information about the research outcomes and sometimes also access to the researchers. The third consists of "going around" entry barriers when these cannot be lowered without damaging the incentive structure of the PP/P. Box 10 gives the example of a "service unit" which connects Dutch SMEs to collaborative pre-competitive research in their field.

Box 10. A special service unit to connect SMEs to a major PP/P – *Kunstoffenhuis* (Netherlands)

The Dutch government does not provide any specific incentive for SMEs to participate in PP/Ps such as the four Leading Technology Institutes, including the Dutch Polymer Institute (DPI). However, several actors (the Netherlands Organisation for Applied Scientific Research (TNO), Technical University of Eindhoven, and Fontys Hogescholen) have established a service unit (the so-called Kunstoffenhuis) to make the results from academic polymer research available to polymer-processing SMEs. This organisation facilitates knowledge transfer by offering consultancy and training and helps SMEs to get aware of the developments in academic research, including the activities of DPI, and of possible benefits for their own business.

Creating international linkages and building global networks

Governments need to address the geographic dimension of networks by: (i) ensuring that their promotional programmes help national actors to access international networks (*e.g.* the Hungarian programme supporting the preparation of proposals for the European Framework Programmes for RTD); (ii) developing the international dimension of PP/Ps (*e.g.* the Co-operative Research Centres of Australia are now forging strong strategic long term research relationships international links with both foreign companies and research agencies).

They must also co-operate to avoid mismatches between the strong regional dimension of most self-organised SME networks, the national scope of many programmes to promote them, and the increasingly global nature of the knowledge infrastructure and of markets for innovative products and services. Box 11 provides examples of initiatives to close gaps within global innovation networks by interconnecting national and local hubs of technology transfer, linking national networks of SMEs with similar needs and complementary capabilities, building global networks of intermediary organisations, and coordinating national support programmes. Some of these initiatives (*e.g.* INSME) make special efforts to correct enduring geographical imbalances in co-operation networks, notably weak North-South and South-South relationships.

Box 11. Weaving a global web of innovation networks

Interconnecting national and local hubs of technology transfer – the IRC network (EU) and the Center for Technology Exchange and Training for Small Medium Enterprises (APEC)

In 1995, the European Commission established the IRC network. From April 2000, it has consisted of 68 Innovation Relay Centres (IRCs) spanning the EU and associated countries. Partly financed by the DG Enterprise Innovation Programme, it has become a leading European network for the promotion of technology partnerships and transfer mainly between SMEs. The IRCs are innovation support service providers mainly hosted by public organisations such as university technology centres, chambers of commerce, regional development agencies or national innovation agencies. They help SMEs find markets for their innovation, identify new technologies to exploit, or search for an innovative solution to a specific technology need.

Created in 1998, the Center for Technology Exchange and Training for Small Medium Enterprises (CTETSME) is a network of networks in each economy, linked electronically at the Asia-Pacific regional level. It focuses on four key areas: human resources development, access to technology and information, access to credit and capital, and access to market opportunities.

Building global networks of intermediaries – INSME (Italy)

The International Network for Small and Medium Sized Enterprises (INSME) is an initiative promoted by the Italian Government through IPI. Its mission is to stimulate innovation and technology transfer for SMEs by promoting a public-private partnership (PP/P) approach with a variable geometry in order to:

1. support the specialisation, integration, extension and internationalisation of existing intermediaries and their networks providing services to SMEs so as to create economies of scale;
2. encourage the transfer of know how, and good practices so as to upgrade the service supply;

INSME acts as a facilitator for alliances, a promoter of networking and a catalyser to strengthen North-South and South-South cooperation.

Coordinating national support programmes – ERA-NET (EU)

The ERA-NET scheme is about the coordination and cooperation of national and regional S&T programmes, including policies to promote networking and public-private partnerships for innovation, in the European Research Area. The scheme will be implemented via an open call for proposals, *i.e.* using a bottom-up approach. The European Commission will pay all additional costs related to the coordination.

Conclusions

To be innovative all SMEs need direct or indirect access to information and external competencies, some of these being only produced in research-intensive and collaborative environments. Such access can be enhanced by networking strategies that many SMEs cannot implement or even contemplate without assistance.

Appropriate networking strategies, barriers faced by SMEs in seizing networking opportunities, as well as appropriate responses by government vary greatly depending on the type of firms considered, especially their level of innovativeness and innovation mode. A "one-size-fits-all" approach is unwarranted, except for setting out the broad framework conditions (*e.g.* competition policy) that should allow market-friendly collaboration in the development and diffusion of new technologies.

For the vast majority of SMEs, creating or reinforcing (mainly non-technological) innovation capacity and promoting their involvement in innovation networks are closely interrelated policy objectives. Government support should focus on early stages of network formation and operation, to correct information imperfections in order to raise awareness about networking opportunities and benefits, and facilitate the search for partners. Once networks are operational the main concern of governments should rather be to make sure that they remain open to new participants (to minimise the risk of "technological lock-in") and do not distort markets.

Governments need to take a more pro-active approach to: 1) promote collaboration among SMEs involved in R&D-intensive innovation; 2) increase SME participation in public-private partnerships for research; and 3) close gaps within global innovation networks.

PART 2. INNOVATIVE CLUSTERS

Part 2 addresses the subject of innovative clusters, as distinct from both innovative firm networks and R&D-intensive industrial sectors. Enterprise clusters have in recent years attracted growing attention among national and sub-national governments. Part 2 briefly reviews the salient features of cluster formation, the competitive advantages that enterprise agglomerations can confer on the firms concerned, and the rationale for and practice of cluster-oriented policies. Among other sources, the paper draws on five recent case studies commissioned by the OECD.[7] These studies focus on the practical experience of policy and programme implementation (a summary of their results are contained in the Annex).

The economics of clustering

The geographic concentration of business activity – otherwise referred to as "clustering" – can give rise to economic benefits for the firms concerned. These benefits are known as "agglomeration economies". Agglomeration economies take many forms, and have been examined in a vast inter-disciplinary literature that dates as far back as Alfred Marshall's Principles of Economics, published in 1890. In the broadest terms, the co-location of firms and their suppliers can give rise to the development of locally concentrated and sometimes specialised labour markets. The presence of a concentration of individuals possessing specialized skills can afford obvious advantages to nearby firms. Clustering can likewise encourage a more efficient division of labour among firms, offering the possibility of scale economies for individual enterprises.

Clusters can also facilitate flows of the ideas and information that underlie innovation. Such information flows occur formally and informally, for example when workers change from one employer to another, or through contacts with common suppliers, and through social interaction. As has been emphasized in an extensive literature on Italian industrial districts, purely commercial inter-firm exchanges are sometimes overlaid by common membership of artisanal, business and labour associations, as well as various community-based institutions. Opportunities are thus provided for frequent association which, it is held, affords a social substrate that could facilitate lowered transaction and other business costs. Clustering can also reduce the unit costs of providing technical services to co-located businesses. And the co-location of firms can help to identify and make practicable a reduction of the costs of certain business activities when undertaken collectively. In addition, by operating in close proximity firms can more easily subcontract to competitors those orders that exceed their own capacities, because proximity can allow greater knowledge of the capabilities of potential contractors. This may allow firms to retain valued customers. Furthermore, Porter (1998) has observed that sheer physical proximity among numerous competing firms can spur innovation when local factor costs are readily comparable.

However, benefits need not arise from clustering automatically, and not all studies find any agglomeration of firms to be associated with competitive advantage. For example, firms – including firms located in clusters belonging to industries other than their own – can experience acute competition for labour and other production inputs. To so extent there is a trade-off between the benefits of clustering and the costs of congestion.

[7] Manufacturers of prefabricated log homes (Montana, United States); Biotechnology and life sciences enterprises in North Carolina (United States); Automotive sector (Slovenia); Digital media and creative industries in Scotland (United Kingdom); Innovation System of Science, Technology and Enterprise (SIV) of Valencia (Spain).

Figure 7. Clusters within innovation systems

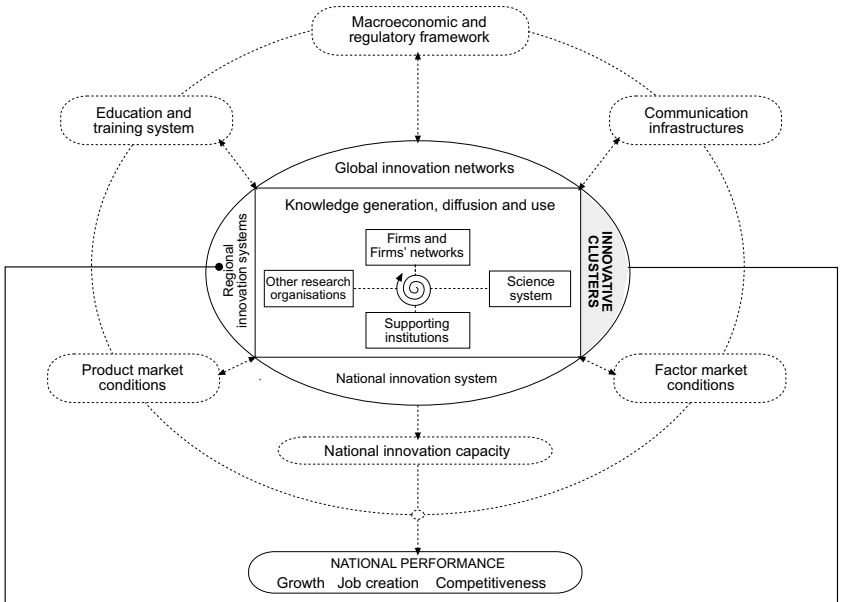


Figure 8. Regions, regional innovation systems and innovative clusters

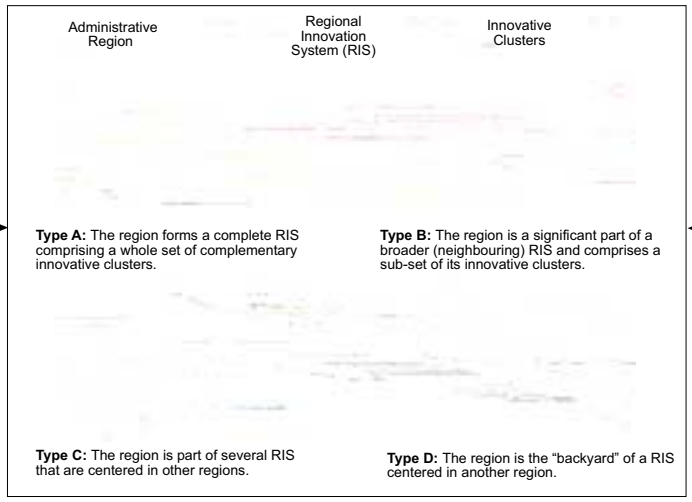


Table 7. A typology of innovative clusters

		Knowledge intensity		
		Low	Medium	High
Sectoral focus	High	Some industrial districts (e.g. shoes, textile)	Sub-contactors co-located around a large firm Some industrial districts (e.g. machine tools)	Small bio-tech firms co-located around a major university or public lab
	Medium to low	Natural resource-based network of small firms (e.g. in agro-food, tourism)	A diversified set of interrelated activities serving a localised physical infrastructure (e.g. the port of Rotterdam)	A diversified set of interrelated activities drawing from a localised knowledge infrastructure (e.g. Silicon Valley)

Source: OECD Secretariat.

It is important to distinguish between enterprise clusters and business networks (Box 12). The two phenomena are frequently referred to as identical. However, they are distinct, have different origins, dynamics and policy implications (see Rosenfeld, 2001). Essentially, enterprise clusters are an outcome of market forces and often involve acute competition among co-located businesses (competition that can occur with simultaneous co-operation on selected business functions). By contrast, business networks, especially those of a more formal nature, are the result of agreements among participant firms. These agreements to co-operate may be informal, or they may be specified formally through contracts and rules. Consequently, membership of a network can be restrictive, whereas membership of a cluster is open. In addition, business networks need not be local in scope. That is, they need not involve the physical co-location of firms. A business network might operate locally, nationwide, or even internationally.

Box 12. Key Distinctions Between Enterprise Clusters and Business Networks

- Networks allow access to specialised services at lower costs.
  Clusters attract specialised services to a region.
- Networks have restricted membership.
  Clusters have open "membership".
- Networks are based on contractual agreements.
  Clusters are outcomes of market dynamics.
- Networks can help firms engage in complex production.
  Clusters generate demand for more firms with related capabilities.
- Networks are based on co-operation.
  Clusters require competition.
- Networks have common business goals.
  Clusters may have collective visions, including public interest.

Based on Rosenfeld (2001).

The role of clusters within national innovation systems is now well established (Figure 7). Innovative clusters can be defined as networks of interdependent firms, knowledge-producing institutions (universities, research institutes, technology-providing firms), bridging institutions (*e.g.* technology extension services) and customers, linked vertically and/or horizontally in a value-adding production chain, and which co-operate in developing and using sector-specific public goods based on common physical and knowledge infrastructures. Clusters (innovative or otherwise) can contain small or large numbers of enterprises, as well as small and large firms in different ratios. They can be more or less knowledge-intensive, involving a comprehensive or more reduced set of knowledge-producing and bridging institutions, and have a narrow or broad sectoral and technological focus since they occur in traditional as well as new industries (Table 7).[8] Noting the ubiquity of the clustering phenomenon, Enright (2000) has observed that clustering can even be seen in some apparently "placeless" activities that might not be considered subject to clustering at all, such as telemarketing and credit card processing. Different clusters involve different degrees of interaction among the firms involved, ranging from informal association to formal and multifaceted cooperation. The extent to which innovative activities are clustered is striking. For example, according to one estimate (from the mid 1990s) there were some 380 clusters of firms in the United States operating across a broad spectrum of sectors in service and manufacturing. Together they employed some 57 percent of the United States' workforce and produced 61 per cent of the country's output (Rosenfeld, 1996).

[8] For example, on of the case studies covers a cluster located in Montana, United States, comprised of manufacturers of prefabricated log homes. This cluster has emerged from a traditional wood-processing industry and is characterized by relatively recent innovations. By contrast, another case study concerns a cluster of biotechnology and life sciences enterprises in the Research Triangle Area of North Carolina.

The physical extent of (innovative) clusters often transcends the various geographic units of public administration and economic regulation (Figure 8 and Table 8). As every collection of firms and industries linked in a value chain cannot be defined as an industrial cluster, and because not every cluster is innovative, it is not the case that every region functions as an innovation system, *e.g.* contains a set of complementary innovation clusters (Figure 8). Clusters generally serve world markets. Localised markets are often served by clusters that are tightly connected to global production and innovation networks. In most clusters one can identify international, national as well as regional elements.

Table 8. Nation-wide and regional Danish clusters of competence

	National	Regional
Existing	• Thermal technology • Technical appliances for the disabled • Pork • Dairy products • Water environment • Fur • Seed-growing • Power electronics • Hearing aids • Wind technology • Maritime industry	• Mobile/satellite communication in Northern Jutland • Business Tourism in the Capital region • Stainless steel in Eastern Jutland • Horticulture at Funen • Pharmaceuticals in the Oeresund region • Textiles/clothing in Herning-Ikast • Offshore industry in Esbjerg • Furniture in Salling • Transport in Eastern-Southern Jutland
Emerging	• Organic food • Children's play & learning • Waste management • Sensor technology • Bioinformatics	• Movies/broadcasting in the Copenhagen region • Oeresund Food Network • PR/Communication in the Copenhagen region • Pervasive Computing in Copenhagen and Aarhus

Source: Dalsgaard in OECD (2001*c*).

The politics of clustering

There are a number of reasons why business clusters and networks have created widespread policy interest. In the first instance, policymakers are aware that membership of clusters and inter-firm networks can enhance the productivity, innovativeness and competitive performance of firms. Clusters can provide a propitious environment for innovative business spin-offs, as has been the case with numerous companies in the information and communications technology sector in Silicon Valley. Clusters and networks can allow small firms to combine advantages of small scale with various of the benefits of large scale. Large scale can afford significant advantages for firms in international markets, while many SMEs are smaller than the efficient optimum in different stages of production, marketing and distribution. Economic liberalisation and the international integration of markets may also reduce opportunities for firms to remain both small and efficient. Such considerations have been a driver of policy towards the creation of enterprise networks aimed at overcoming the constraints of limited scale.

Demonstration effects likewise play a role. Internationally-renowned clusters are numerous, including, for example, financial services in New York, London and Frankfurt, carpet manufacture in Dalton, Ohio, fashion in Paris and Milan, special effects for film in Los Angeles and London, among many others. The presence of dynamic clusters in affluent regions such Emilia Romagna in Italy, Baden-Würtemberg in Germany, Cambridge in the United Kingdom, Sophia Antipolis in France, and many others has focused policy interest. Indeed, cluster development initiatives are now almost universal, having been adopted in developed and developing economies, in wealthy and lagging regions, and in jurisdictions with laissez-faire and dirigiste approaches to economic development (Enright, 2000). The frequently disappointing results of economic development strategies based on attracting large-firm investment have

also spurred interest in clusters-oriented policies (Enright, 2000; Storper, 1992). The structure of some clusters can also lead to high rates of enterprise start-up, an issue of widespread interest among policymakers. In areas with significant concentrations of SMEs there is often a high degree of vertical mobility in the labour market, with workers frequently aspiring to become owners of SMEs themselves. The inter-firm specialisation that clusters can permit may lead to a low degree of vertical integration among firms, lowering barriers to entry. A fertile environment thus exists for enterprise creation.

The genesis of clusters

Few significant innovative clusters have been created through public action. Clusters are almost always the result of market dynamics. The specific economic drivers of cluster formation can include the following:

- *Proximity to markets*. Despite low-cost international transportation, being near to markets can still be important in cluster development. Examples include the concentration of automotive component suppliers around producers in the Midlands of the U.K. and the city of Graz in southern Austria.
- *Supplies of specialised labour*, such as exist around many universities.
- *The presence of input and equipment suppliers*. A high frequency of interaction between co-located capital goods producers and users may be a source of competitive advantage for firms in many industrial districts.
- The availability of specific natural resources.
- *The availability of infrastructure*. Some forms of infrastructure may also be highly specific, such as with certain transport facilities, further encouraging agglomeration.
- *Low transaction costs*. If the frequency of interaction among firms and their suppliers is high, which is more likely when companies operate near to each other, informal understandings may lead to reductions in the costs of contract negotiation and enforcement. This effect may be strengthened by social norms that affect entrepreneurs who belong to the same social groups.
- *Superior access to information.* For example, the availability of important forms of information, that can be accessed through *inter alia* social and professional networks, may be high in the vicinity of some universities and research institutes.

Governance structures and the basic tool kit of cluster policies

Issues of governance are important to the success of cluster initiatives and cluster organisations. It is key that the focus of policy be demand and market driven. This requires close participation with the private sector and as close an adherence to market rationality as possible. The case studies suggest an increasing sophistication in the forms of public intervention being adopted. For instance, the case studies provide clear evidence that the public sector role is being framed as one which is indirect and catalytic (a key recommendation adopted in the Bologna Charter) and must evolve as a cluster matures. The Slovenian automotive cluster programme, for example, is led by the private sector but was government initiated. The North Carolina's Biotechnology Center was initially a public body but later became a private not-for-profit corporation. Today the NCBC acts as a neutral non-partisan institution spanning industry, academia and government. And Scotland's principal economic development agency, Scottish Enterprise, has a clear exit strategy from its intervention to facilitate the development of that country's creative industries.

Box 13. Key Observations arising from five case studies*

Five case studies have been prepared covering: a cluster in Montana, United States, comprised of manufacturers of prefabricated log homes; a cluster of biotechnology and life sciences enterprises in the Research Triangle Area of North Carolina; an initiative in the automotive sector in Slovenia; digital media and creative industries in Scotland; and the system of Science, Technology and Enterprise in Valencia. The five cases were chosen for the variety of contexts and forms of intervention that they encompass, as well as for their focus on different aspects of innovation. For instance, in Montana, there has been no overarching cluster or network strategy. Rather, interventions have been disparate and multiple. In Scotland, on the other hand, an explicit network programme has been heavily resourced. Can any generic lessons be derived from this diverse set of experiences, noting that the case studies are not quantitative and involve no comparator firms or localities? A key observation here is that nothing in the cases suggests that the policy recommendations on clusters and networks contained in the Bologna Charter should be revised. The principles underlying the economic rationale for clusters/networks interventions still apply.

Networks of different sorts are central to the reviewed programmes

The case studies clearly point to the importance of networking. Indeed, in the Scottish creative industries cluster the firms themselves asserted that the most valuable function that Scottish Enterprise could perform would be to ensure a continued dialogue among the enterprises concerned. None of the cases stress the role of geographic proximity, with networks operating across space.

The clusters are playing a role in human resources development

Several of the cases highlight the importance accorded to human resources development by cluster-based schemes. For instance, the Montana Logging Association was seen to conduct employee accreditation workshops and to work with the University of Montana to identify the new skill needs and develop a Western Montana Logging Program for incumbent workers. Talent attraction and recruitment events have been important in the Scottish case.

Initiatives appear to be taking on considerable sophistication, with governments adopting a facilitatory role

While these case studies may not be representative of cluster/network initiatives across the OECD area, they do perhaps suggest an increasing sophistication in the forms of intervention. There is for instance the impression that the public sector role is being framed as one which is indirect and catalytic (a Bologna recommendation).

Policy must be framed over the medium-term

The studies also suggest that this is a field in which policy needs to be patient. It can clearly take a number of years for programmes to become established and for inter-firm collaboration to become a norm. Programmes that persist often also appear to move from a project-based form of implementation to a more membership-based governance arrangement.

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* See highlights at the end of Part 2, and more detailed summaries in the Annex.

Many types of cluster organisation exist. Some are public agencies, such as the development arms of local governments. Others are private organisations, such as industry or employers associations or chambers of commerce. Some are public-private partnerships or wholly autonomous organisations. The typical functions of a cluster organisation are to provide a forum for interaction and collaboration among firms, an interface between firms in a cluster and the government, and mechanisms for interaction between firms and other supporting institutions, such as universities, research centres, and sources of finance. The appropriateness of the governance system will depend on the nature of the cluster organisation. For example, public sector organisations need to be accountable to government and the public and at the same time need to provide services and support useful to the firms in the clusters in question. This suggests that a private sector board of directors or an advisory board drawn from cluster participants is desirable. Public-private partnerships are best set up as autonomous organisations with joint public and private oversight.

Cluster development strategies often share marked similarities (see Box 13 for an overview of insights and lessons learned from the case studies). Many concentrate on the provision of support services for small and medium sized enterprises. Others provide generic business and economic information, or information relevant to the markets, technologies and competitors relevant to the cluster. Specific infrastructure and training requirements of the clustered firms are a focus of many programmes. Programmes often use a variety of means to foster business networks and trust among firms in the cluster

(see the following section). Indeed, an emphasis on inter-firm networks predominates in the case studies prepared for the Istanbul Ministerial conference. Governments sometimes provide business development services of different sorts, from basic research to advice on cash-flow management.

For instance, schemes vary as to the level of government involved. While the public sponsors of cluster strategies are usually local and regional governments, national and even supranational institutions have also played active roles. Central government in the United Kingdom, for example, recently announced the creation of a 150 million pound clusters and incubation Challenge Fund (to be administered through regional development agencies). Another area of difference relates to whether programmes focus on developing the existing economic base, or attracting firms into the cluster, or a combination of the two. Programmes also differ with respect to the techniques and criteria used in the identification and selection (Enright *et al*, 2001). Some programmes use detailed criteria, such as projected sectoral growth, local multiplier effects, the magnitude of estimated job creation and incomes growth, relationships with local suppliers, etc. However, programmes often converge as regards the sectors assisted. The sectors of choice are frequently the "sunrise" industries such as biotechnology, new materials, information technology and telecommunications (Enright *et al*, 2001). However, there is no valid economic reason for prioritising these sectors over others. The fact that such sectors are frequently targeted (sometimes in neighbouring areas) highlights the risk of destructive competition that poorly designed cluster initiatives can engender.

Implementing inter-firm networking as part of a cluster policy: challenges and good practices

Efficient business networks are at the core of successful clusters. There is abundant empirical support for the proposition that entrepreneurs who establish and maintain ties with other entrepreneurs often outperform those who do not. Business network initiatives are much in vogue and, unsurprisingly, the generic term "network" covers diverse forms of collaboration. For instance, networks of friends and family often give critical financial, emotional and other support to entrepreneurs. By contrast, strategic alliances among firms frequently arise so as to compensate for lack of scale. Of relatively recent policy interest are formal mechanisms of co-operation among groups of small firms, and sometimes among small firms and larger enterprises within innovative clusters. Such networks operate with varied forms and objectives. Some aim at the sharing of general business information. Others seek to achieve narrower goals.

The benefits that can derive from networks have been well documented (see Part 1 above and Enright *et al*, 2001). For instance, networks can allow rapid learning – and small companies often prefer the learning from peers that networks permit. Networks can also lead to the restructuring of relationships with suppliers. And in some cases networks have led to a new and more efficient division of labour among a group of firms. Networks can also allow the realization of benefits from collective action in a variety of business functions. For instance, small firms in the Australian city of Perth have engaged in the collective purchase of expensive information relating to intellectual property. Small companies in the Italian town of Mirandola, home to one of Europe's largest concentrations of biomedical companies, jointly bear the costs of quality assurance services. And in 2001, around 10 000 SMEs located around Barcelona organised through various territorial networks in order to purchase electricity at a significantly reduced rate. In fact, networks have involved co-operation on issues as diverse as training, technological development, product design, marketing, exporting and distribution. Some network initiatives, such as the *Danish Network Programme,* begun in the early 1990s, have had the explicit intention of helping small firms acquire efficiency, as a group, to match that of larger enterprises. Rosenfeld (2001) has even observed that government agencies in the United States have begun to use networks as a cost-effective means of aggregating demand and delivering services to small firms.

However, networks are not a risk-free prescription for small firm development. Difficulties are often encountered in forming structured and durable forms of co-operation. And a recent survey of British

SMEs suggests that few benefits have accrued to firms in networks of enterprises belonging to the same sub-sectors. This research found that collaboration in the development and operation of supply chains demonstrates the only significant relationship between co-operation and the performance of SMEs (Robson and Bennett, 2000). There is also some evidence that firms might approach network schemes because they are in difficulty or need to compensate for managerial deficiencies (Bates, 1994). The way in which a programme is designed, the quality of its management, and the nature of the participant firms, will all affect the likelihood of eventual success.

OECD (2003) and Enright *et al* (2001) detail a set of policy recommendations on business networks, which complement the more general observations presented in Part 1 above:

Implement broad campaigns to introduce the networking concept to businesses

For a variety of reasons, the first step in creating a network programme should be to seek to create informed demand for network services. Comprehensive network schemes have sometimes failed to receive continued financial support from participating firms once public subsidy was withdrawn. In part, this appears to have reflected the fact that the private sector has on occasion been presented with a menu of services previously decided by public economic development organisations. Indeed, a supply-driven approach to network schemes has been a common weakness.

Business networks that most often have a positive impact on corporate performance are typically established to achieve specific commercial objectives. Private agents generally have superior information on where good commercial opportunities for networking lie, but may lack familiarity with the concept of networking. It is therefore important that public authorities and business associations seek to raise awareness of the benefits and opportunities of networks, so as raise informed demand for programmes built around the commercial goals identified by the private sector.

Participants' expectations are also likely affect the longevity of network programmes (Huggins, 2000). For instance, business clubs and fora often operate over extended periods of time, with membership usually involving little expectation of short-term financial gain. This again suggests that networks be demand-driven, structured around objectives determined by businesses, in this way incorporating the expectations of private firms into the design of the programme. Lastly, where programme resources are scarce, an argument can be made for policy to focus on raising the overall level of associative activity among firms. More structured, perhaps contract-governed, forms of networking could be left for private agents to organize themselves.

A degree of financial support, in feasibility work, start-up activities, and network brokerage, is necessary

Aversion to and unfamiliarity with inter-firm co-operation, as well as problems of co-ordination, create barriers to the spontaneous emergence of networks. Public action, at least in a catalytic role, is often needed. However, funding should be phased out as participants start to benefit from the programme.

Work with realistic time-frames

Policy needs to be framed over the medium-term, with a period of 3-4 years often required for a significant business network programme. Moreover, the development of new network programmes around new goals should be a constant feature of policy.

Ensure the presence of experienced network brokers

As with many programmes to support business development, the quality of management is critical. Persons with direct experience of managing an SME should be employed as network brokers,

providing an impartial source of advice and mediation for firms hesitant at the prospect of co-operation. Network brokers can also help allay concerns over any unfair appropriation of benefits among participating companies. Establishing teams of brokers and facilitating exchanges of experience among them can help improve effectiveness. Training and accreditation programmes for brokers might also be valuable, as practitioners often assert that generic knowledge of fostering collaboration, rather than sectoral expertise, matters most. Information technology holds the promise of expanding network access and creating better links with research bodies, education and training institutions. However, experience suggests that frequent face-to face encounters are essential for maintaining engagement amongst networked firms.

Cluster policies in a national and global context; coordination challenges and responses

Policy towards clusters should be based on government supporting existing and emerging clusters rather than trying to create clusters from scratch. A policy aimed at developing entirely new groups of firms in selected sectors can entail high costs, high risks, serve as a screen for outmoded forms of industrial targeting, and give rise to destructive competition should many regions follow the same policies in pursuit of the same industries. Underlying programmes of cluster development is the idea that firms derive their competitive position from being a part of larger interlinked economic, infrastructural, institutional and even social systems. It is clearly extremely difficult for governments to create and manage the development of such complex systems through policy. Accordingly, an indirect role for government is preferable. Furthermore, while agglomeration economies exist – otherwise business clusters would not form – policy makers generally lack the information with which to judge their magnitude in different industries for agglomerations of different scales (Bartik, 1990). Furthermore, diseconomies of agglomeration – say from congestion or pollution – may occur as clusters increase in size. Consequently, beyond a given scale, public subsidy of agglomeration will reduce economic efficiency, with policymakers almost always lacking the information to judge when this occurs. Such considerations again suggest that the public sector adopt a facilitatory role, and should avoid seeking to act as the architect of the spatial distribution of business activity. In a sentence, policy should be co-operation positive, but agglomeration neutral.

In some countries sub-national organizations pursue cluster development programmes that target similar sub-sectors. For instance, many States in the United States have sought to develop clusters in “sunrise” industries such as new materials, biotechnology, information technology, etc. From a sub-national perspective such efforts may appear rational. However, they are clearly economically wasteful from a national standpoint. A policy which addresses firms in existing clusters – that is, clusters that are experiencing a market test – will help to avoid wasteful competition financed from public resources. In other words, co-ordination challenges at the national level become less acute when policy is non-distortionary and facilitatory.

At a local level, co-ordination failures occur when, as part of a group, individual firms are unable to act in their own best interests. For instance, potential joint gains may be lost if small firms lack a suitable forum through which to act together, or when a history of antagonism in an industry creates barriers to collaboration. Porter (1998) provides an example from the Portuguese wood products industry in which overall productivity growth was made possible only when various firms in the cluster – such as loggers and sawmills – upgraded together. Providing oversight, information and a forum for co-ordination is clearly a public sector role.

Co-ordination of cluster programmes at the international level is rare, but becoming more common. Denmark’s Ministry of Industry, for instance, has recently sought to identify opportunities for collaboration among enterprise clusters in Denmark and clusters found elsewhere in Europe. Some clusters straddle national boundaries, in which case policy co-ordination among national and/or sub-national authorities may make sense. There also exist some notable cases in which entrepreneurial and technical know how, as well as capital, are flowing from established clusters in one country to emerging clusters in

another. For example, in recent years, Chinese and Indian entrepreneurs who have achieved success in high-technology firms in Silicon Valley have played a role in the emergence of high-tech clusters in Taiwan and India. And public authorities in Italy's Marche region, a major centre of footwear manufacture, have sought to bring about collaboration between enterprise agglomerations there and agglomerations in the same sub-sector in Mexico. However, the cluster here serves as a vehicle for generating interest and bringing about co-ordination among the Italian manufacturers – much as might occur through a Chamber of Commerce in other contexts.

Also noteworthy here is that development agencies have invested considerable resources in the selection of clusters for programme support. Two broad types of selection criteria are often used: criteria relating to the cluster's institutional and organizational readiness (such as the presence of a representative institution in the cluster), and criteria that reflect inherent economic and/or technical features of the clustered firms. However, both selection approaches are problematic. In the first case, choices that are based on whether a cluster possesses organised representation beg the question of whether the development of such representation should be a programme goal. In the second case, selecting clusters on economic characteristics – such as the extent of local value addition, sectoral growth prospects, local multiplier effects, etc. – raises many of the problems of traditional industrial targeting.

There are usually no sound economic reasons why markets would systematically undersupply resources to the industries deemed critical. In practice, the choice of clusters with which development agencies might work will often be self-evident, given limited local economic diversity. However, when there are numerous candidate clusters, some rationale for selection may be required. Policy makers would ideally possess information on the costs and benefits of a range of potential *project* activities in the various candidate clusters (Nolan, 2002). In this connection, the most attractive projects need not exist in those clusters that have greatest weight (or prospects) in the local, regional or national economy. Higher-return projects might exist in nascent, small or even declining clusters. Faced with a ranked opportunity set of projects, the aim would be to select good projects rather than good clusters. This observation highlights the importance of a process of continuous information exchange with the private sector. Such an exchange is critical because firms generally have superior information on potential opportunities for, and gains from, collaborative projects in their industries. Public actors can facilitate this process of exchange by publicising instances of collaborative action that have worked elsewhere. There may also be benefits to working with a portfolio of clusters (with the clusters that present superior opportunities for good projects becoming the targets of support).

Conclusions

Governments can nurture the development of innovative clusters primarily through regional and local policies and programmes to stimulate knowledge exchange, reduce information and co-ordination failures and strengthen co-operation among firms as well as between firms and knowledge institutions. The development of innovative clusters can also be enhanced by providing appropriate policy frameworks in areas such as education, finance, competition and regulation. More direct policy tools can also be used to encourage cluster formation and development, such as public-private partnerships for R&D, public procurement, and competition for government funding to provide incentives for firm networks to organise themselves on a regional basis. Recent OECD work, including the five case studies, suggests that efficient cluster policies:

- Build a shared vision, based on a sound assessment of initial conditions, and ensure a continuous and active dialogue between industry and government in defining and implementing the cluster development strategy.
- Catalyse local initiatives by bringing actors together and supplying enabling infrastructures and incentives.

- Work with existing or nascent clusters instead of trying to "pick winners". Make policy co-operation positive, but agglomeration neutral.
- Improve availability and access to key resources (skilled people, R&D, physical and "intangible" infrastructure, smart money).
- Avoid "high-tech" or "manufacturing" myopia, recognising the importance for innovation-led growth of knowledge-intensive services and the technological upgrading of traditional industries.
- Build on existing innovation networks, but keep incentive schemes open and attractive to outsiders, especially new firms.
- Customise policy approaches to fit the specific needs of different industry and technological fields, since, depending on clusters' characteristics, government has a variable role in addressing the following problems: lack of interaction; informational imperfections; mismatch between knowledge infrastructure and business needs; inadequate demand (Table 9).
- Leverage regional resources through interregional co-operation and participation in national and international innovation initiatives.
- Allow experimentation and learning-by-doing in an area where there is still a large scope for improved international diffusion of good practices.

Table 9. A "customised" cluster policy in the Netherlands

Projects[1] / Role of government	Antheus	Twinning	ITS	Life sciences	Water cluster	Mass individualisation	EMVT	Construction	PDI	ECP.nl
Chairman										
Catalyst/initiator										
Process manager										
Brokers										
Connecting networks										
Finance										

Note: White = no role; Grey scale = intensity of role.

1. Antheus is a regional cluster project at the micro level, aimed at increasing co-operation between a large aluminium plant and the smaller (aluminium-using) firms surrounding it. ITS stands for Intelligent Transport Systems. EMVT is the Dutch abbreviation for Electro Magnetic Power Technology. PDI stands for Product Data Interchange, a project mainly aimed at supporting this technology in the chemicals cluster.

Source: Gilsing in OECD (2001*c*).

Box 14. The 5 case studies – Highlights

Case study 1 covers a cluster of ***manufacturers of prefabricated log homes*** in Montana, ***United States***. This cluster has emerged from a traditional industry, and is characterized by relatively recent innovation. The study presents an interesting example of how a comparative advantage (in this case based on access to raw materials) has been eroded over time but superseded by advantages in design and brand. To date there has been no explicit cluster development policy, although policy formulation is now incipient, with a State-sponsored plan for the cluster having been completed in May 2003. This plan will initially target issues of skills upgrading and the formation of a council to assume responsibility for identifying the issues and priorities facing the cluster. Different interventions have come about through the Montana Manufacturing Extension Service, the Agricultural Extension Service, and the University of Montana. Collaborative endeavour – in particular in skills development – has been spurred in large measure by the private sector, through the Montana Logging Association. This cluster, though relatively small, is important to the state of Montana because of its potential for expanded markets associated with growing interest in vacation homes in the US. While companies produce log homes in many parts of the US, Montana has developed the highest concentrations and strongest reputation. Although the cluster has developed with minimal public sector support, the state now considers that it has the ability to catalyze faster growth with selective interventions.

Case study 2 concerns a cluster of ***biotechnology and life sciences*** enterprises in the Research Triangle Area of North Carolina, ***United States***. This is now one of the most significant clusters in this sector in the US. The origin of the cluster dates back to the early 1970s. A critical step in the development of the cluster was taken with the establishment of the North Carolina Biotechnology Center (NCBC), initially as a public body but later as a private not-for-profit corporation. The NCBC acts as a neutral non-partisan institution that helps industry, academia and government pursue biotechnology research, development and commercialization with a view to contributing to the long-term economic development of North Carolina. Both the NCBC and the Council for Entrepreneurial Development are frequently held to be important to the cluster's success. Amongst its other achievements, the NCBC has invested more than $50 million to improve the biotechnology research capabilities of the state's universities. It has helped to triple university enrolment in the biosciences, and has created the North Carolina Genomics and Bioinformatics Consortium, a partnership of more than 70 universities, companies and non-profit institutions working to advance these fields in the state. The NCBC has also provided $8 million in early financial assistance to 62 small biotechnology companies, which have gone on to raise $460 million from other public and private sources. It has created the $26 million North Carolina Bioscience Investment Fund to provide venture capital for new biotechnology and related bioscience companies. Nevertheless, the cluster faces challenges. These include acute competition for biotechnology investments across US States and indeed internationally, the need to ensure a continuous supply of suitably skilled labour, the effects of relatively poor infrastructure, and the need for a larger talent pool of entrepreneurial executives, managers and business founders.

Case study 3 concerns the ***automotive sector*** in a transition economy, ***Slovenia***. The initiative stemmed from the Minister of the Economy's desire to promote long-term economic growth based on industries with high value added and productivity. The program began in 1999. Quantitative analysis was used to identify the leading industries for each of 12 statistical regions. A qualitative analysis followed to identify links between companies and between companies and universities, R&D institutions and other organizations. The final step was to identify product and service systems in terms of innovative potential through a review of factors of innovation such as patents, employment in R&D departments and export orientation. Ten potential clusters were identified, including the automotive sector. The government provided financing for pilot cluster initiatives for one year renewable for a second year. The companies were expected to contribute 60% of related costs. The process was intended to be "bottom-up", with authority and responsibility resting at the firm level. As of spring 2003, the cluster organization (ACS) comprised 22 companies and 5 research institutions and faculties. It employed a full-time director, full-time project coordinator and part-time advisor. Each company had a coordinator who participated in monthly coordination meetings. In practice, this group functioned like an advisory council. Annual fees were €2 000 for large companies, €1 000 for medium-sized companies and €500 for small companies and R&D institutions. The activities of the cluster were grouped into six areas: 1) promotion; 2) R&D/supply chain development and common purchasing; 3) cluster infrastructure development; 4) Intranet development; 5) education; 6) quality and business excellence. While the program is still in a pilot phase, individuals across the industry have started to network, learn about each other's capabilities, and identify opportunities for collaboration. Small companies have found that access to markets and common promotional activities have been especially valuable benefits of cluster membership.

Case study 4 deals with ***digital media and creative industries*** in Scotland, ***United Kingdom***. In the mid 1990s, Scottish Enterprise, identified a range of industries as possible components of a meaningful cluster, which acquired the name "creative industries." These industries included firms in music, design (including fashion design and crafts), publishing, new media (including multimedia and Internet), computer games and packaged leisure

software, films, broadcasting (including TV and radio), advertising, architecture and cultural industries (museums, art galleries, antiques, etc.). Scotland's creative industries are estimated to contribute approximately 4% to Scottish GDP and around 70 000 full-time equivalent jobs. The early stages of engagement primarily aimed to promote communication between creative sectors and Scottish Enterprise (Scotland's principal economic development agency) and among the creative industries themselves. The creative industries cluster initiative was primarily run by the national office of Scottish Enterprise, although there is no dedicated separate office for the creative industries initiative. Support is generally delivered through existing bodies such as Local Enterprise Companies and industry associations. When the action phase of the cluster intervention was launched in April 2001, the programme had resources of £25 million over a 3–5 year period. There is regular interchange and collaboration with other clusters to monitor areas of opportunity in overlapping industries such as bio-informatics. There is regular evaluation of progress and annual updating of baseline data to track the progress of the cluster. To date, the initiative appears to have performed well in the four focus areas. Linkages between industry and academia have been improved, and new spin-offs have been generated. Penetration of export markets has improved through trade missions and international events. To attract talent to the cluster special talent events and recruitment fairs have been carried out. A digital media quarter is under construction in Glasgow and plans include a new Digital Media Park in Dundee.

Case study 5 concerns the ***Innovation System of Science, Technology and Enterprise*** (SIV) of Valencia, ***Spain***. This case focuses on a broad set of region-wide institutional and policy interrelationships, rather than a narrow geographically focused cluster programme. The main administrative, scientific and technological institutions involved in the SIV are: the Science and Technology Office; IMPIVA (the Valencian Institute of Small and Medium-sized Industrial Enterprises); REDIT (the Network of Technological Institutes of Valencian Region) (17); 6 Universities; 32 University Institutes; 10 CSIC Centres (National Council of Scientific Research); regional Research Centres and 4 European Innovative Enterprises Centres. At the organisational level, the Consellería (regional Ministry) of Innovation and Competitiveness is the Department of the Government with competencies in the field of science and technology policy. The Regional Plan on Scientific Research, Technological Development and Innovation (PVIDI) 2001-2006 has recently been approved. The Plan is structured around the improvement of scientific knowledge and technological innovation and the strengthening of competitive capacities. The PVIDI represents an important effort of co-ordination and prioritisation of governmental activities, essentially directed at reinforcing the link between research and innovation. The PVIDI has been structured, in some priority areas, around three types of programme, each of which has achieved positive results developing its own activities. The three programme types have been: General Knowledge Programmes; Sector Programmes; and so-called "Own Programmes" which are proposed and financed by the different Departments of the Government. While important problems persist – such as the scarcity of private sources of finance – the Valencian Innovation System is rapidly converging with national and European standards in the field, and is now producing visible results. These results are being seen not just locally, but also in terms of technology exports and technology transfer to other regions and countries.

PART 3. INTELLECTUAL PROPERTY (IP) RIGHTS AND INNOVATION IN SMES

The expression "knowledge-based economy" refers to the new economic environment in which the generation and management of knowledge play a predominant part in wealth creation, as compared with the traditional factors of production. In the OECD countries, the rise of the knowledge economy is evidenced by the growth in the knowledge-based industrial and service sectors, which are increasing their share in the overall economy. Despite the economic slowdown in recent years, the knowledge intensity of OECD economies continues to increase and private sector investments in R&D continue to rise.[9]

A crucial factor determining a company's decision to invest in innovation is the extent to which it will be able to recoup its investments and make profits once its R&D effort results in an innovative product or process. The generation of new knowledge generally entails high costs – in the case of technology, the costs relate to R&D investments – while the costs for copying or imitation are typically low. In addition, the "public good" characteristics of knowledge and innovation make it difficult for businesses to "appropriate" the results of their R&D investments. If R&D expenditure is unlikely to result in higher profits for the firm there will be a strong disincentive to invest in innovation in the first place.

The system of IP rights creates a mechanism to resolve the "appropriability" and "tradability" problems of knowledge, by creating property rights over knowledge for a limited period of time. Intellectual property (IP) rights may be defined as exclusive rights granted by the State for the commercial exploitation of the results of human creativity and inventiveness. IP rights apply, *inter alia*, to inventions, new/original designs, trademarks, literary and artistic works including computer software and new varieties of plants. By providing a fair degree of exclusivity over the exploitation of innovation(s), the system of IP rights creates an incentive to invest in scientific, technological, and organizational R&D activities so as to reduce the risk of free-riding by others while commercially exploiting product and process innovations.

The creation of property rights enables the exercise of ownership over the intellectual output of R&D activities. This is done by creating, using, and leveraging IP rights that enable the owner of IP rights to enter into negotiations with others in order to take a new product to market through various kinds of partnerships. Often, these partnerships are based on special contractual arrangements known as licensing contracts that permit third party use of one or more types of IP rights in exchange for a valid consideration in cash or kind. A secure access to IP assets, through ownership or licensing of IP assets, may also be important for obtaining funds from financial institutions and investors, particularly business angels and venture capitalists.

In addition to providing an incentive to innovate, IP rights particularly patents and utility models, play a key role in the diffusion of new technological information as patent documents are published, in most countries, 18 months after the filing of the relevant patent applications. The public disclosure function of the patent system facilitates the diffusion of new technical knowledge and potentially reduces the amount of "wasteful" duplicative R&D. It has been estimated that patent documents contain 70% of the world's accumulated technical knowledge and that most of the information contained in patent documents is either never published elsewhere or is first disclosed through the publication of the patent.[10] In the

9 OECD, Science, Technology and Industry Scoreboard (2003.

10 European Patent Office, The EPO Guide to Patent Information on the Internet.

1990s, most national IP offices of OECD countries, as well as the EPO, have made available their patent databases on-line for the general public to consult free-of-charge. This makes patent databases a potentially invaluable source of easily accessible technical information for researchers and firms, which, as explained below, remains largely unexplored and under-utilized by enterprises, particularly small and medium-sized enterprises (SMEs).

The focus on innovation will naturally draw the bulk of the analysis in this paper to the patent system. However, it is important to bear in mind that innovation in its broadest sense may be protected through a variety of different intellectual property rights, depending on the nature of the innovation, the sector a company is operating in, the legal instruments available in a given country and a company's business strategy. The main types of IP rights are: (1) patents and utility models (for inventions), (2) trademarks, (3) industrial designs, (4) valuable undisclosed information or trade secrets, (5) lay-out designs of integrated circuits (6) copyright and related rights, (7) new varieties of plants, (8) geographical indications, and (9) non-original database rights. In many countries, the law on unfair competition often expands the scope of protection of new or original knowledge that may not be adequately protected by the relatively stronger but narrower rights associated with ownership of one or more of the above-mentioned types of IP rights.

Intellectual Property Rights in the Knowledge Economy

The centrality of knowledge as a source of productivity gain and competitiveness has recently placed the intellectual property system at the centre stage of the knowledge economy. Statistics on patent applications and patent grants show a significant increase in patenting over the past two decades leading to what has generally been termed a "pro-patent era."[11] In the United States, for example, the total number of patents granted by the USPTO has been rising by 6% a year since the mid-1980s. The surge in patent applications has been particularly significant in knowledge-based industries such as biotechnology, information and communication technologies (ICT), nanotechnology or advanced chemicals. For example, the growth of biotechnology applications in the European Patent Office (EPO) since 1993 has been of 14.3% a year, compared to 8.3% for total patent applications.

Part of the reason behind the surge in patenting is due to an increasing trend among firms to patent in more foreign markets, which is a direct result of the "global" approach taken by many firms, including SMEs in a number of high-technology sectors. In addition, the increase in patent applications also reflects the increased value companies attach to patents, which may be due to a variety of reasons.

Firstly, the shift towards knowledge-based industries has placed increasing importance on intangible assets as the source of competitive advantage for firms, thus increasing the importance of having such assets protected. In the knowledge economy, many firms rely on licensing revenues derived directly from their IP rights (*e.g.* royalties) as their main (or even as the sole) source of income, becoming producers of knowledge, which is shared via licensing agreements with a number of other companies for its commercial exploitation.

Secondly, the outsourcing of manufacturing activities to subcontractors, both domestically as well as in low-cost locations, has also intensified the need for outsourcing companies to retain ownership over the innovative and creative aspects of their products, which are the basis of their competitive advantage in a number of sectors, including some low-tech sectors.

Thirdly, legislative changes at the national, regional and international levels have led to increased protection for IPRs in many countries, increased international harmonization of the IP system as well as

[11] Kortum and Lerner, 1997.

easier access to IP protection in foreign countries.[12] Changes at the institutional level providing a more conducive environment for the enforcement of IP rights, such as the establishment of the Federal Court of Appeals for patents in the US in 1982, are also thought to have been partly responsible for the surge in patenting (see Merges, 1992).

Fourthly, the expansion of patentable subject matter has also played a significant part. The landmark case of Diamond v. Chakrabarty (1982) produced a flood of patent applications for biotech-related products and sparked the impressive growth of the biotechnology sector in the US and subsequently in the other OECD countries. Business method patents and software patents are also examples of areas where patenting activity has increased remarkably in countries where such patents may be obtained.

Fifthly, the Bayh-Dole Act, enacted in the United States in 1980, marked a turning point in the history of university – industry relations leading to a surge in patenting among universities and public-sector R&D institutions. By creating a uniform patent policy for all federal agencies that fund research and enabling universities to retain title to government-funded inventions, the Act provided a national policy framework to encourage universities and other non-profit organizations to collaborate with commercial enterprises in the commercialization of inventions and new technologies.[13] Since the enactment of the Bayh Dole Act, many other countries have followed suit passing legislation and establishing an institutional framework to encourage university-industry collaboration and facilitate the commercialization of university research results *via* its transfer to the private sector.

The above issues all point in the direction of a more active utilization of the IP system, particularly in the OECD countries, reflecting a higher perceived value of ownership of IP rights. Structural changes to the economy, increasing importance of intangible assets as a source of competitive advantage for firms, legal and institutional policies encouraging the use of IP as a means for the transfer of technology from research institutes and universities to industry as well as changes to the IP system in favour of the right holders has made the IP system increasingly attractive and in many cases indispensable for all economic agents.

SMEs and Intellectual Property Rights

Over the past two decades, government policies have consistently sought to encourage innovation among the SMEs sector, on the understanding that the development of a vibrant and dynamic SMEs sector requires constant creativity and innovation to adapt to fast-moving market conditions, short product cycles and intense market competition.

SMEs, however, are an extremely heterogeneous group. Their innovative capacity and ability to develop new and innovative products, processes and services varies significantly, based on their sector, size, focus, resources and the business environment in which they operate. In certain high-technology sectors, such as semiconductors and biotechnology, innovative SMEs have been a key to the growth and dynamism of these sectors. In such sectors, patenting activity is comparatively much higher than in other sectors and small firms rely heavily on patents to signal expertise, either to attract research partners or investment (see Mazzoleni and Nelson (1998). Patenting is generally considered particularly important in

12 TRIPS Agreement, Articles 41 to 61.

13 For more on the Bayh-Dole Act, see website of the Association of University Technology Managers at: http://www.autm.net.

"discrete product industries" (*e.g.* pharmaceutical or chemical industry) as compared to other manufacturing industries where it may be more difficult to appropriate R&D results through patenting.[14]

For new technology-based firms (or NTBFs), reliance on IP rights for a competitive edge is increasingly important. NTBFs are new firms established for the purpose of commercializing new technology or providing an innovative service on the basis of new technology. Such enterprises generally have limited capital and tangible assets and largely depend on intangible assets such as their innovative capacity and human capital to succeed in the marketplace. The innovative idea is usually the main asset of the company during its start-up phase and the basis on which it will seek investors to contribute to its efforts to take the product or service to market. For technology-based entrepreneurs and start-ups it is critical to find ways of appropriating their innovative ideas, products and processes in order to survive in the marketplace, obtain a competitive edge over competitors and have a credible business plan to present to investors.

In a number of other sectors, however, innovation by SMEs mainly consists of minor adaptations to existing products, innovation in designs, mode of service delivery or management and marketing practices. In many such sectors, SMEs' innovations are mainly of an informal nature, without formal R&D investments, R&D laboratories or R&D personnel. In such cases, other intellectual property rights, such as utility models, industrial designs and trademarks may play a bigger role than patents in providing a competitive edge to SMEs. IP rights such as trademarks and industrial designs may provide companies with the ability to differentiate their products, segment markets, create a brand image, find niche markets, target specific customer groups and obtain exclusivity over the commercial use of a mark or design that may be the main selling point of a new or improved product or service.

The rise of the information and telecommunications industries and the increasing importance of the services sector in the economy of OECD countries has also enhanced the importance of the copyright system as a tool for protecting the creative efforts of companies in, for example, the software and multi-media sectors, as well as in many other sectors which rely on creative work protectable by copyright. The traditional focus of the copyright system on artists and writers, has increasingly expanded in the current economic context to include computer programmers and other new categories of creators in the entertainment, software or teaching industries, to name a few. The entry into force of the WIPO "Internet Treaties", the Digital Millennium Copyright Act in the US and similar legislation in other OECD countries are increasingly providing a legal framework for the exchange of copyright-protected products and information on the Internet. For the vast number of SMEs operating in such industries, royalty revenues from the licensing of their copyrighted works is generally the main or only source of income. The existence of a well-functioning copyright well-functioning copyright and related rights system is often crucial for the survival of many such firms and industries.

Aside from providing the exclusive right to prevent others from commercially using an invention, design, trademark or literary or artistic work, IP rights are often used by a firm to meet a wide range of other ways to improve the chances of success and profitability of a business. Depending on the IP strategy of each firm, IP rights may be used to: obtain access to new markets (*e.g.* by licensing another company to manufacture a new or improved product based on a patented invention and/or protected trade secrets); enhance the reputation of a company as a technology leader through access to, or ownership of, key patented technologies; creating a corporate identity through a trademark and branding strategy; segmenting markets through different designs targeted to different customer groups; increase the bargaining power of the enterprise vis-à-vis business partners or investors; avoiding wasteful investments in R&D by consulting

[14] Levin et al. (1987) and Cohen et al. (2000) provide evidence of the greater value attached to patents by companies operating in so-called "discrete product" industries. Arundel and Kabla (1998) estimate that industry average patent rates range from 15% in base metals and steel to 74% in pharmaceuticals.

patent databases and learning about recent technological developments; establishing strategic alliances, joint ventures or other types of partnerships with other companies with complementary assets; setting up a franchising system on the basis of the company's trademark and other IP rights; increase the market value of the company in the case of a merger or acquisition; obtain additional revenues through licensing or sale of IP rights; provide access to new financing opportunities (such as through securitization of IP assets) or support a request for funds from a financial institution, bank, business angel or venture capitalist.

The list is by no means exhaustive. The strategic use of IP rights by enterprises, including SMEs, will highly depend on the company's overall business strategy. Effective management of IP rights may provide new business opportunities for companies with the appropriate skills, innovative capacity and resources to benefit from the range of options offered by the IP system.

SMEs are often constrained in many more ways than larger enterprises in making an effective and efficient use of the IP system. The heterogeneity of SMEs in terms of their ability to innovate and to use existing technology is also reflected in the ways that such enterprises use the IP system; it varies widely from company to company, sector to sector, country to country, and over time. The crucial point to note is that SMEs of varying sizes and levels of technological sophistication may benefit from different aspects of the intellectual property system according to their specific needs and technological capacity. In the knowledge-based economy, it is their ability to use the IP system efficiently and effectively, which will largely influence their capacity to make the most of their creative and innovative capacity and recoup their investments in creativity and innovation. The important question is, therefore, the extent to which SMEs are currently aware of, have access to and are making an effective and efficient use of the IP system and, if not, what are the barriers that are preventing them from doing so.

Barriers faced by SMEs in using the IP system

Studies from various OECD countries reveal that SMEs face a number of difficulties in using the IP system. This is often the result of their limited knowledge of the ins and outs of the IP system, lack of clarity about its relevance to their business strategy and competitiveness, and of their finding the system too complex and expensive to use. Available studies/research on the use of the IP system by SMEs is largely limited to the use of patents. This empirical evidence paints a picture in which the propensity to apply for patents is highly related to the size of the company. This is the case even when focusing exclusively on innovative companies. The evidence is somewhat similar, though to a lesser degree, for trademarks (WIPO, 2003).

In a survey done by the Institute of Roland Berger Forschungs for the European Patent Office (EPO) on the use of the patent system by the production industries (excluding micro-enterprises and enterprises in the handicraft sector), it was reported that one out of every three companies are potential patent applicants as they engage in R&D activities, but only one in six actually do apply for patents (EPO, 1994). According to the survey, SMEs that do not apply for patents stated that the main reasons for not doing so are the costs and time needed for filing applications, while some SMEs also mentioned the ineffectiveness of the patent system. The survey also concluded that there is a major information deficit among SMEs on the patent system, which leads to a low level of filing of patent applications by potential applicants, and a lack of active government support to assist SMEs in the patenting process given the large number of barriers faced.

The costs of patenting are generally perceived as one of the greatest barriers for SMEs.[15] In budgeting the costs relating to the acquisition of IP rights, companies need to take into consideration not only the official fees (including application fees, publication fees and maintenance fees) but also the costs

15 See, for example, Derwent (2001), Cordes (1999), European Patent Office (1994).

relating to legal advice and translation costs whenever the applicant intends to apply for protection abroad. Overall, the costs of protection may be perceived by many SMEs as exceeding the potential benefits to be obtained from protection, particularly considering that a significant part of the costs may be incurred before the product has reached the market and that lenders, investors or government programs rarely provide financial support for the protection of IP rights.

Nevertheless, evidence gathered by some national IP offices (*e.g.* the Danish Patent and Trademark Office) suggests that a reduction of fees for SMEs would not necessarily lead to an increase in the number of patent applications from that sector. It may be that the other costs related to patent protection, other than the official application fees may be more of an obstacle, or that the perception of high costs, complexity or ineffectiveness of the patent system especially in terms of enforcement of patent rights may be more of a limiting factor than the actual costs involved. However, it may also be that the reasons for low use of the patent system by SMEs may be totally unrelated to costs of application but relate, for example, to business strategy, to a limited knowledge of the IP system or to limited access to expert advice on the subject matter. More research on these issues is required.

Aside from the costs, there are a number of additional elements of the application process that may act as a disincentive for SMEs to seek IP protection, including the time required to be granted a patent or to obtain a trademark registration. The increasing number of applications at some of the large IP offices has often led to an increase in the backlog and therefore an increase in the time required from application to grant of a patent or registration of a trademark. For SMEs, a long delay for obtaining a patent leaves a great degree of uncertainty and delays the possibility of finding potential licensees or partners for exploiting an invention.

In a recently published WIPO study on the use of the IP system by SMEs in Norway, attention is drawn to the fact that small companies not only apply for patents less often than large enterprises but also that when they do apply their success rate (in terms of being granted the patent) is significantly lower. This suggests that SMEs that invest in protecting their inventions are often not effective in obtaining the title of protection. Reasons for this may be many, ranging from insufficient information on the prior art, poorly drafted patent applications, limited access to adequate legal advice and lack of resources (human and financial) to follow the application through to the grant stage (WIPO, 2003). It is to be expected that failure to obtain a patent or, after grant of patent rights, failure to successfully exploit the granted patent, may also discourage SMEs in applying for patent protection in the future.

In terms of IP protections in foreign markets, a recent report by the General Accounting Office (GAO) of the US identified high costs, limited resources, and limited knowledge among small businesses about foreign patent laws and systems as some of the greatest obstacles faced by American small businesses in applying for patents abroad. The GAO report expressed a concern that small businesses, particularly high technology firms, were losing potential sales in foreign markets by not applying for patent protection abroad. Empirical data suggests that small firms file for fewer patents abroad than do large firms (*e.g.* Mogee, 2000).

Given some of the barriers faced in using the patent system, SMEs often use alternative means of appropriating their innovation. Some of the alternatives to patenting include secrecy, exploitation of lead-time advantages, moving rapidly down the learning curve, use of complementary sales and service capabilities, technical complexity, on-going innovation, relationships based on trust and use of trademarks to differentiate their products from those of imitators.[16] It is often noted that secrecy and lead-time advantages may be the most common way of appropriating innovations among firms, particularly (though

[16] A number of studies have focused on studying the ways in which firms appropriate innovation, including, Levin et al (1987), Cohen et al (2000), Kitching et al. (1999).

not exclusively) among SMEs. One of the main reasons for this is that a large variety of innovations may lack the inventive step to be protectable under the patent system (in such cases utility models, where such protection is available, or industrial designs may be suitable alternatives) or because process innovations or innovations in certain low-technology sectors are less likely to be patented. In addition, the costs related to patent protection will act as a disincentive to patenting whenever firms do not expect to obtain sufficient benefits to cover the expenditure related to patent protection (*e.g.* when the commercial potential is limited).

With respect to the use of secrecy as a means to appropriate innovation, companies may rely on legislation on trade secrets and/or unfair competition for the protection of their confidential business information. Trade secrets are intellectual property rights recognized as such by international agreements such as the WTO/ TRIPS Agreement. However, very little is known on how SMEs protect their trade secrets and to what extent they are aware of the protection offered by specific national laws on trade secrets and/or laws on unfair competition that also deal with protection of trade secrets. There is a general perception that SMEs often use trade secret protection by default, *i.e.* as a way of avoiding the expenditure and administrative procedures involved in patent protection, without taking adequate measures that need to be in place for confidential information to be considered a legally protectable trade secret. According to most national IP laws, for a trade secret to be protected, there is a need to prove that (1) the information is secret (*i.e.,* it is not generally known among, or readily accessible to, circles that normally deal with the kind of information in question), (2) it has commercial value because it is secret, and (3) the rightful holder of the information has taken all possible reasonable steps under the circumstances to keep it secret or confidential (*e.g.*, through confidentiality agreements, non-disclosure agreements, etc.).

An additional element that must be taken into account when analyzing barriers to use of the IP system by SMEs is the issue of enforcement of IP rights. The difficulties that firms may face in monitoring the use of their IP rights in the marketplace and in enforcing them may act as additional disincentives to applying for protection in the first place. [17] In a recent survey of patenting firms in the European Union, it was argued that in 49% of sampled firms, fear of the costs of patent-defence litigation had an impact on investments in generating inventions.[18] In the US, the enforcement of IP rights is more of a problem for small enterprises than for large firms; while patents owned by small firms are infringed more often than those owned by large firms, the small firms are much less likely to litigate (Koen, 1992).

An area that has not been fully explored, is the extent to which SMEs use titles of protection other than the patent system. Raw statistics on applications for utility models and industrial designs have shown that, with some exceptions, SMEs have generally made limited use of these two forms of protection, despite them being considered titles of protection that would appear to be most suited to SMEs. For example, it appears that SMEs, in most countries where designs may be protected by copyright and as registered design rights, rely more often on copyright as a means of protection, as it does not require registration as a condition for creation of copyright. Again, it would be appropriate to inquire whether reliance on copyright is the result of conscious business strategy (in which case, appropriate measures to keep necessary evidence to prove ownership would be required) or whether reliance on copyright is by default as a result of limited knowledge of the existence of industrial design protection or as a way to avoid the costs involved in industrial design registration.

Not only is the propensity to apply for the protection of IP rights among SMEs low, but so is the use of the information contained in patent databases. Various studies have shown that the use of patent information as a source of technological information rises with firm size.[19] The Community Innovation

17 See, for example, Cordes and Koen

18 European Commission, *Enforcing Small Firms' Patent Rights* (2000)

19 See Arundel and Steinmueller (1998).

Survey shows that 34% of large R&D performing firms find patent information important, while only 18% of R&D performing SMEs and 5.9% of non-R&D performing SMEs do so. For most enterprises, trade fairs, information from suppliers and specialized magazines remain preferred sources of information. This is so because of their lack of awareness of the wealth of information available in patent documents, limited skills to conduct patent searches, lack of familiarity with patent jargon and inability to interpret the "claims" in patent documents. Basic training in this area would enable entrepreneurs, researchers and engineers in SMEs to benefit from the public disclosure function of patents.

For NTBFs, as for most SMEs, funds remain the most scarce and valued resource. NTBFs reliance on intangible assets complicates the process of obtaining loans from financial institutions including commercial banks and venture capitalists. Protection of intangible assets as IP rights slightly improves the situation, particularly when dealing with venture capitalists and business angels, though less so with commercial banks. According to a study commissioned by the European Commission[20] the difficulty involved in valuation of intellectual property assets is an important reason as to why such assets cannot be used effectively as collateral. The survey pointed out that none of the surveyed European commercial banks accepts intangible assets such as intellectual property, as security for a loan. "This is not to say that intellectual property is not recognized – concluded the study – as part of the overall assessment the banks insist that it be properly protected." In some countries, where venture capital markets are well developed, patents are crucial and often indispensable to have access to any funding for NTBFs. Developing reliable mechanisms to put a value on intellectual property rights and the further development of markets for IP assets would help in creating a more NTBF-friendly environment with easier access to funding on the basis of the IP rights.

The barriers to a wider and more effective use of the IP system by SMEs are, therefore, many. In the first place, low awareness of the system limits the exposure SMEs have to the IP system and their ability to use all the elements offered by the IP system effectively, including not just patents but also utility models, trademarks, industrial designs, trade secrets, patent databases, copyright and other IP rights. Poor IP management skills within SMEs reduce their ability to fully benefit from the system and, therefore, discourage its future use. Secondly, limited access to the necessary human resources and/or accessible legal advice make use of the IP system complicated and decreases the chances of success in the application process for registration/grant of IP rights. Efficient IP management requires an array of skills ranging from the legal to the scientific/technical and the commercial that not all SMEs have in-house. In fact, such expertise is generally lacking in many if not most SME support institutions; this is equally true of SME consultants and business advisors in the private sector. Thirdly, high costs, not just for acquiring and maintaining but also for monitoring and enforcing IP rights are an additional barrier, particularly for firms that are operating in a number of geographically dispersed markets.

Government measures for enhancing a more effective use of the IP system by SMEs

In most countries, including those in the OECD, the national Intellectual Property Offices (IPOs) have been historically perceived as being responsible for the IP system at the national level. The IP system was traditionally detached from innovation policy, SME policy, entrepreneurship policy, or science and technology policy. It was generally seen as a separate legal sphere of little direct relevance to the broader innovation promotion or competitiveness strategy of a country. As such, IP offices dealt almost exclusively with the registration and grant of IP rights and were generally not involved in debates on how to stimulate innovation, notably among entrepreneurs and SMEs.

In recent years, the increasing importance of IP rights in a knowledge-based economy has begun to change the way national, regional and local governments view intellectual property rights and the IP

[20] European Commission, *Guarantee Mechanisms for Financing Innovative Technology*, (2001)

system as a whole. In many countries, there has been a shift in the focus of national IPOs. While the traditional functions of IPOs in the area of examination, registration and grant of IP rights (mostly limited to patents, trademarks and industrial designs) still remains the central element of their day-to-day work, IPOs are increasingly devoting resources to a range of additional services aimed at facilitating the access to, and reaping the benefit from, the IP system by various users of the IP system, including researchers, entrepreneurs and SMEs.

The information gathered by the SMEs Division of WIPO on the basis of a survey of IP offices and SME support institutions shows that activities for facilitating a wider and more effective use of the IP system by SMEs generally fall into five main categories: [21]

1. Awareness-raising and training on IP;
2. Technological information services;
3. Financial assistance;
4. Customized advisory services on IP;
5. Assistance for IP exploitation and technology transfer.

The bulk of activities specifically targeted to the SME sector have focused on awareness-raising and advice on procedural matters concerning the application for IP rights. These activities take into account that low awareness and limited knowledge of the IP system by SMEs is perceived in many countries to be one of the main challenges that needs to be addressed.

The range of awareness-raising and training activities in which IP offices have been active include the following:

- organization of seminars, conferences and campaigns on IP for entrepreneurs and SMEs;
- IP guides and other information material on various aspects of IP for entrepreneurs and SMEs;
- web sites with practical information on IP issues for entrepreneurs and SMEs;
- collection and dissemination of case studies illustrating the success stories of SMEs in leveraging IP assets;
- building IP content into customized training manuals for entrepreneurs and enterprises operating in specific sectors (*e.g.* biotechnology, software, agriculture, multimedia, etc.);
- general advice to applicants on administrative issues relating to the application process (*e.g.* helpdesks within IP offices);
- multi-media products with information and advice on management of IP assets;
- IPO participation in business fairs;
- contribution of articles on IP issues to business magazines targeting entrepreneurs, researchers and SMEs;

[21] See “Best practices” section of WIPO’s website at: www.wipo.int/sme/en/best_practices

- regular radio and/or television programs on issues relating to intellectual property and innovation;
- integrating IP issues into the national/institutional teaching and training curricula and course material for entrepreneurs, engineering and management students;
- proactive visits to SMEs.

It is increasingly clear that government institutions, in order to be successful in their activities for promoting a wider and more effective use of the IP system by SMEs must seek to target not just the entrepreneurs themselves but also their business advisers, whether they be private sector consultants, or employees of chambers of commerce and industry or investors and employees of financial institutions who are more likely to be heard by the entrepreneur and managers/owners of SMEs. In addition, promotion activities on IP have generally proved to be more effective when included in other activities seeking to meet some of the most immediate needs of SMEs, such as marketing, new product development, exporting, financing, etc. In other words, for IP to be included in the business strategy of enterprises it must also be integrated into the overall framework of business support services of those seeking to promote it.

Box 15. IP Australia – Becoming Market-Oriented

IP Australia has taken an active role in raising awareness and educating SMEs about the importance of the intellectual property (IP) system. In 1998 it established a marketing department in order to conduct training and promotion activities which are aimed at the general public, including the SMEs. Its main activities in this area include:

- A customer-oriented website with practical information targeted to specific customer groups (including inventors, start-ups, companies in the agricultural industry, creators, researchers, government institutions, designers, exporters, etc.).
- Strong focus on training and providing support to business advisers.
- Reader-friendly publications and easy-to-use multi-media products with a range of case studies. Over 35 000 information kits on IP are distributed every year.
- The IP Toolbox, developed in conjunction with industry, has become a reference book for a wide range of organizations even outside Australia.
- Regular seminars on various aspects of IP for SMEs.

Some OECD IP offices have sought to go beyond the awareness-raising and training phase by providing a wide range of *technological information services* to their clients. The technological information provided in patent documents provides a point of departure for understanding the technological trends in specific fields or in monitoring the activities of competitors. However, the raw information contained in patent databases may be of limited use. This is why a number of IP offices provide value-added technological information services, turning the raw information provided by patent databases into more workable knowledge that can be of practical use to firms in developing new and improved products and services for improving the chances of success of their business strategy.

Box 16. Exensis IP Search – Technological Information Services in Switzerland

The new status of the Swiss Federal Institute for Intellectual Property as an autonomous self-financing institution has led to a radical reorganization and enhancement of the services provided in the field of patent information. The objective is to help customers to incorporate intellectual property and patent information into their corporate strategic decision processes. This is facilitated by generating a series of search modules, a selection of which can be linked together optimally to meet a customer's needs. Typical modules include technology trend analysis, portfolio assessment and competitor analysis, and embrace patentability and infringement patent searches. The objective is further facilitated by the formation of partnerships with organizations that have complementary skills. More information is available at: http://www.exensis.ch.

Initiatives aiming at supporting enterprises in using the technological information contained in patent documents also include:

- regular workshops for entrepreneurs and managers/owners of SMEs on how to use patent information;
- free on-line access to patent databases;
- provision of a range of technological information services for SMEs at a reduced price;
- establishment of patent libraries with specialized staff within universities, technology parks, business incubators, research centres and chambers of commerce and industry;
- regular provision of information on recent patents in a given technical field or "technology alerts";
- development of multilingual IP databases (*e.g.* SurfIP of Singapore).

Box 17. The PATLIB Network in Europe

In cooperation with the national IPOs of the member states, the European Patent Office supports a network of patent information centres ("PATLIB Centres") throughout Europe. These have evolved from a grouping of national PATent LIBraries widely distributed in the member States. PATLIB Centres are located in national patent offices, chambers of commerce and industry, science parks and universities. The PATLIB Centres provide patent information by searching available national and international patent databases. Many PATLIB Centres additionally provide information on trademarks and industrial designs. A number of Centres have developed patent awareness modules, workshops or training programs for their users. Some Centres cooperate with patent attorneys or business advisers who regularly visit the Centre to provide clients with advice. A number of Centres have acquired their own specific profile by providing special services and products. Examples of specialties are pro-actively contacting potential clients such as SMEs who are generally not able to afford an in-house information bureau and offering assistance, organizing so-called "patent clinics" where clients can make appointments to obtain basic advice from patent attorneys or business advisors free-of-charge and providing interactive training packages. The PATLIB Network is being expanded continually. In 1995, there were 116 Centres. By October 2003, the number had increased to 283.

To partly overcome the barrier of limited access to relevant legal information on IP rights, some IP offices have ventured into providing *customized legal and technical support* in the field of IP to their clients. In a number of cases this has been done through the establishment of decentralized offices of the IP office in order to reach out to entrepreneurs and enterprises located far from the national capital, which is usually the headquarters of the national IP office. This has generally had a strong impact in terms of bringing such IP offices closer to their users. In other cases, IP offices have contributed to the establishment of patent libraries or other new types of institutional structures, often in partnership with universities, chambers of commerce and industry, science parks or other new types of institutional structures for improving access of entrepreneurs and SMEs to basic legal and procedural advice on how to go about applying for IP protection.

Box 18. Decentralization of the IP Office in Mexico

In Mexico, the decentralization of the national IP office in the year 2000, via the creation of regional offices throughout the country, has led to a significant rise in patent and trademark applications by nationals residing outside the capital. As an illustration, the number of resident patent applications filed from the Western region of the country increased from 35 in 1999 to 329 in 2001 largely as a result of the work of the Western regional office. The work of the regional offices includes promotion, support in drafting applications, legal advice and receipt of applications. The rise in the number of applications has led to a subsequent concern: ensuring that patents and trademarks are adequately used and exploited by their owners. Regional offices are therefore increasingly concerned with issues of commercialization, licensing and technology transfer in order to assist their clients to manage their IP assets.

For IP offices and/or their partners, before becoming involved in the direct provision of legal advice or value-added technological information services on IP it is important to ensure that there are no conflicts of interest (given that IPOs are also in charge of processing and examining the IP applications) or that the IP office is not perceived to be taking over activities that should ultimately be provided by the private sector on a full-fee recovery basis. The objective of any such activities should be to address a "market failure", and to awaken a latent demand for such services. This should be done in such a manner that facilitates the development of a market sector that is capable of providing such services to entrepreneurs and SMEs at an affordable price.

With a few exceptions, very little effort has been directed to enabling SMEs to effectively use and commercialize their IP assets. In fact, IP offices are not ideally placed to play this role, which has to be played by the SMEs support institutions and/or by the private sector business consultants and advisers who are the prime source of support for entrepreneurs and SMEs in most countries. A few national IP offices have sought to provide mechanisms to bring together patent holders lacking funds to commercialize their products with potential licensees in order to increase the proportion of patents that reach the market as innovative products (*e.g.* Japan and Korea) through the establishment of technology markets. The Danish Patent and Trademark Office, acknowledging the importance of proper valuation of IP assets of firms, has sought to develop *a practical tool for the valuation of IP assets*, known as IP Score®, for commercial purposes thus encouraging the development of a market for IP rights.

From the point of view of the application process at the IP offices, a number of recent trends have contributed to making the system more accessible to inventors, researchers, entrepreneurs and SMEs. In the first place, the introduction of *electronic filing* by many IP offices has made an important contribution in reducing the transaction costs faced by enterprises in filing their applications. Secondly, the availability of *procedures for pre- and post-grant opposition* at the IP offices as well as for a quasi-judicial review of the granted patent, makes it easier to contest titles of protection without having to enter into potentially expensive litigation in courts. Thirdly, a number of countries (*e.g.* Japan and Spain) have introduced procedures for the *accelerated grant* of patents upon request by the applicant in certain specific circumstances, thus reducing the time required for patents to be granted. This may be particularly important, for example, for companies that have already identified a potential licensee for their innovative technology.

At the legislative level, the *introduction of utility model protection* (known in some countries as "petty patents" or innovation patents) in a number of countries, where such protection was previously not available, is also perceived as an important development for inventors, entrepreneurs and SMEs. Utility models are considered an instrument of protection that is particularly suited to small enterprises with limited R&D capacity but capable of making incremental changes or adaptations to existing products. Utility models are generally cheaper than patents and faster to obtain and often have lower requirements than patents in terms of threshold of inventiveness. The recent *introduction of the unregistered community design* in the countries of the European Union may also have an important impact in providing an easily accessible means of protection for SMEs operating in the fashion industry or in products with designs that

are linked to short-term or passing trends. It would also provide SMEs with possibility to test market their products before going through the effort and expense of registering all designs.

Box 19. The "Innovation Patent" in Australia

The "Innovation patent", launched in Australia in 2002, was introduced as a result of extensive research into the needs of SMEs, with the aim of providing a "low-cost entry point into the intellectual property system." Applications under the new innovation patent are less expensive, are of shorter duration (8 years), may not undergo a substantive examination (unless requested by the applicant or a third party) and have a lower inventiveness requirement than is the case for standard patents. [22]

Despite all the above initiatives at the level of the IP offices, it is crucial that initiatives seeking to make a real impact in increasing awareness and enhancing a more effective use of the IP system by entrepreneurs and SMEs manage to *incorporate IP within the broader development framework of support for new and existing SMEs*. Increasing cooperation between institutions providing support to entrepreneurs and SMEs and institutions involved in the National Innovation System, such as universities, R&D centres, IP offices, incubators, chambers of commerce and industry, SME associations, inventors associations and venture capitalists is crucial to address the issue of IP promotion for SMEs in a holistic manner with greater coordination and collaboration amongst institutions.

The ambitious goal of assisting new and existing SMEs to become and remain competitive, through a more effective use of the IP system, can only be really attained if all the relevant actors in the public, private and civil society sectors in the OECD countries make sustained efforts to bridge the gap in awareness of, access to, and use of the IP system by inventors, researchers, entrepreneurs and SMEs. This has begun to happen in some countries, but efforts are generally still scattered. For example, in the Republic of Korea, close cooperation between the Korean Intellectual Property Office (KIPO), the chambers of commerce, the government SME support agency, the Korean Patent Attorneys Association and other public and private partners, including financial institutions, business training centres and multinationals have established a network of support for SMEs in IP matters.

Box 20. Working in Partnership in Korea

The partnership between a number of Korean public and private sector organizations is based on five main strategic objectives: (1) IP Acquisition Campaign for SMEs; (2) Assisting in the Creation of IP; (3) Reducing the Cost of Acquiring IPRs; (4) Activating the Marketing of IPRs; (5) Supportive Measures for Commercialization.

By means of illustration, in partnership with the Korean chambers of commerce, KIPO has established patent information centres in a number of chambers of commerce throughout the country. In addition, in order to address the cost barrier faced by SMEs in patenting their inventions, the Korean Intellectual Property Office (KIPO) and the Korea Patent Attorneys Association (KPAA) signed a business cooperation agreement to initiate a partnership that provides SMEs with free patent management services from pre-filing to registration for their first patent application. The purpose of the agreement was to pave the way for small and medium-sized enterprises' first procurement of patent rights in a convenient and economical manner. For patent attorneys, the free service was seen as a way of gaining a new client base.

Research at WIPO on IP support services to SMEs has led to the conclusion that in many countries, government and non-government institutions responsible for supporting the growth of

[22] See Government response to the Recommendations of the Advisory Council on Industrial Property (ACIP) Report "Review of the Petty Patent System": http://www.ipaustralia.gov.au/patents/what_innovation_review.shtml

entrepreneurship and development of SMEs have begun to include intellectual property related services within their programs of support for SMEs. This has particularly been the case in the following areas:

- Innovation promotion programs;
- Programs aimed at promoting the development of specific priority sectors (*e.g.* biotechnology, software, nanotechnology, and advanced or new materials);
- Export-promotion programs;
- Teaching of IP from a business perspective to science, engineering/technology and management students;
- Training programs for inventors, researchers, entrepreneurs and owners/managers of SMEs;
- R&D funds to promote the commercialization of R&D results and the acquisition of new technology by SMEs; and
- Cluster development and regional economic development initiatives.

It must be noted that in most OECD countries the range, scope and performance of these services continues to be very limited; as a result these have made limited difference to the performance, productivity, competitiveness and success of entrepreneurs and SMEs.

However, the provision of technological information services within innovation programs, the inclusion of IP modules within training programs for entrepreneurs and other similar activities have contributed to bringing intellectual property within the broader framework of innovation, entrepreneurship and SME support programs.

Box 21. Enterprise Ireland – Integrating IP into Business Development Services

Enterprise Ireland is the government organization charged with assisting the development of Irish enterprises. Each enterprise that approaches Enterprise Ireland (E.I.) for support is initially assigned a "Development Adviser" who guides it through the services offered by E.I. Services offered relate primarily to six key business functions, namely: Business Planning & Information, Research, Development & Design, Production & Operations, Marketing & Business Development, Human Resource Development and Finance for Growth.

Within the Research, Development and Design function, E.I. has established the "Intellectual Property Assistance Scheme" which offers advice on the protection of inventions, funding for patent applications and advice on the development and commercialisation of inventions. Funds for patent applications are loans which may cover 100% of the costs for the initial application phases in exchange for a share of royalties or sales derived from the patented invention.

The problems faced by SMEs, particularly NTBFs, in raising funds for the development of new technologies, has led some countries to begin to explore ways in which IP rights may be of use for obtaining funds. A few public sector institutions providing venture funding to SMEs have began to consider *IP as collateral/security* for loans. In the aftermath of the "dot.com crisis" questions have been raised as to the extent to which such an approach may be viable in the long run, and whether it could ever become a widespread practice. For public funds to be invested in supporting the R&D activities of inventors, researchers and SMEs it is important, however, to ensure that R&D results obtained with the support of public funds are properly protected in order to enhance their commercial exploitation. It is also important that prior to investing in specific innovation projects, a proper patent search is conducted to ensure that funds are not being devoted to duplicative research. More IP-conscious policies on public sector venture loans or grants would generally be desirable.

Another means by which many OECD countries have sought to encourage innovation among SMEs is tax incentives. Within such *tax incentives* there are, in some cases, provisions providing tax exemptions for royalty income deriving from patents (*e.g.* Ireland), income tax relief for R&D activities which include the protection of R&D results, or tax breaks on the acquisition of proprietary technology. The approach to taxation has varied significantly from country to country.

In addition, many countries have established mechanisms for *supporting the protection of patents, trademarks and designs in foreign markets* as an essential part of their export promotion programs. This also includes assistance in gaining access to international application filing systems for patents, trademarks, and industrial designs (*i.e.* the PCT system for inventions, the Madrid system for trademarks and The Hague system for industrial designs). A number of programs focus specifically on *innovation support* and include IP advice and financial assistance to protect IP rights as an integral part of the innovation process, such as the Austrian Innovation Agency, the INSTI Project (Germany), the Stenbeis Foundation (Germany), or TEKES, the Finnish National Technology Agency. On occasions, programs are sector-specific and cover a range of issues that are of importance for innovative firms in a given sector. An important aspect of such programs is that they treat IP as a component of a broader service package aimed at helping SMEs with a number of aspects of the innovation process.

Box 22. Financial Support for IP Protection Abroad – Spain

In order to alleviate the financial burden relating to patent applications and to promote the protection of intellectual property assets by Spanish enterprises abroad, different government institutions in Spain provide grants and subsidies to SMEs. Most of these grants form part of broader programs for the promotion of a particular economic sector or grants for helping companies to access foreign markets. Such programs include:

- *"Soft" loans by the Center for Industrial Technology Development* (CDTI)*:* the CDTI Technology Promotion Projects are specially designed for Spanish enterprises that engage in patent activities abroad and provide soft or interest-free loans, on a number of different activities including technology transfer and patent applications.
- *Subsidies under the Foreign Trade Initiation Plan:* designed for Spanish SMEs which have their own product or service and non-consolidated exports not exceeding 30 per cent of total turnover. The program aims to help companies in surmounting some of the barriers they face in expanding into international markets. The program provides subsidies to companies for the registration of patents and trademarks abroad, covering not just the application fees but also the legal fees.

In addition, a number of provinces provide grants linked to export-assistance programs or programs designed to increase the competitiveness of regional enterprises, for example by making improvements to the design of their products. Grants generally cover the costs relating to applications for patents, marks and industrial designs and, in some cases, also the costs of acquiring patented technologies and know-how.[23]

New technology-based firms (or technology start-ups) are perhaps best placed as potential customers for programs seeking to assist the development of a dynamic and innovative SMEs sector which is capable of making effective use of the IP system. The fast development of business and technology incubators throughout the OECD countries over the last decade provides evidence of conscious government and non-government efforts to reduce some of the barriers faced by entrepreneurs during the start-up phase. Given the reasons for lack of use of the IP system and its importance as a tool for innovation management, it seems that there is a strong case for providing *IP services within or through business incubators*, particularly technology incubators. Facilitating access to legal, technical and financial support for access to and use of the IP system by tenants of incubators may be important for assisting start-up firms to adequately manage their innovations, by identifying, protecting, exploiting and enforcing their IP rights. In addition, access to expertise on how to search patent databases may also provide entrepreneurs

[23] See: http://www.oepm.es/internet/ayudas/primera.htm

with a wealth of business, technological and legal information that could be important for the development of new or improved products and services.

A recent pilot survey done by WIPO on the intellectual property services provided by European high-tech incubators illustrated the extent to which incubators are including IP within the support services to SMEs. The results of the pilot survey indicate that most IP rights are considered either very important or quite important by the majority of the responding incubators. In addition, IP ownership, or having a license to use the IP rights of others, is considered an important or very important factor while selecting tenants for incubators. Incubator managers acknowledge that a company that has not protected its innovative technology, has not conducted a patent search to verify whether its alleged new inventions are part of the "prior art" or are already owned by others, or has not requested a license to use a particular proprietary technology may face serious problems in taking a new product or service to market. 60% of responding incubators have personnel responsible for IP advice while a few that do not, have links with external partners who offer support on IP matters. It is important to point out that very few of the responding incubators provide any support in areas such as IP enforcement and the valuation of IP assets; that is, in areas which are considered to be important for NTBFs but in which most incubators lack expertise.[24]

Box 23. INPI France reaching out to universities and incubators

In order to train and enhance the professionalisation of IP exploitation departments in universities as well as business incubators and raising the level of awareness of researchers as well as creators of new businesses, the French National Institute for Industrial Property (INPI) developed a plan of activities. In this context, INPI provides training courses for managers of technology transfer departments, customized strategic IP diagnoses, help in drawing up IP modules for teaching and training, privileged access to INPI IP databases and strategic and competitive information search services for universities and incubators.[25]

Promoting interaction between universities, public R&D centres and SMEs in the field of innovation and technology transfer has also been the target of many government and university programs. It is generally felt that a closer interaction between university and industry would enable enterprises (and society as a whole) to benefit from the innovative capacity of universities. In that context, transparent and clear rules on ownership of intellectual property and equitable sharing of income generated by commercialization of IP rights has often been perceived as a key mechanism for creating the appropriate incentives to enhance such interaction. Different countries and institutions have adopted different policies in terms of defining the ownership of IP rights, royalty-sharing mechanisms, how to resolve conflict of interests and other similar issues that arise when public sector institutions and universities become involved in patenting their R&D results. It is worth noting the important impact of the Bayh-Dole Act and similar legislation in other countries has had in favouring the commercialization of university research results, often by means of licensing to, or establishment of, technology-based SMEs.[26]

24 WIPO Survey of Intellectual Property Services of European Technology Incubators: http://www.wipo.int/sme/en/documents/pdf/incubator_survey.pdf

25 See presentation of Pascal Duyck at: http://www.wipo.int/sme/en/activities/meetings/oecd_03/index.htm

26 For more information on patenting at universities and public sector R&D institutions, see: OECD, Turning Science into Business: Patenting and Licensing at Public Research Organisations (2003).

Box 24. Business-University Collaboration – The Lambert Review

In 2002, the UK Government asked Richard Lambert to examine how the long-term links between business and British universities can be strengthened to the benefit of the UK's economy. The Lambert Review, was developed on the basis of consultations with over 500 universities, businesses and industry organizations, and concluded that "uncertainty about IP ownership is one the main barriers to effective technology transfer and research collaboration". The UK government has been active in seeking to promote university-industry technology transfer and the UK Patent Office published guidelines in IP management in universities in 2002.[27]

In the field of enforcement, the debate on possible solutions to the problems faced by SMEs has been on the European Union agenda for some years and a number of proposals have been made to address the issue, ranging from the enhancement of *arbitration and mediation* as a means for settling IP disputes, [28] the establishment of compulsory *IP insurance* or the creation of a Patent Defence Union.[29] A 1999 report by the EU recommended the introduction of compulsory expert arbitration as a solution to the excessive costs of patent litigation.[30] A working group of the European Patent Organization recommended the introduction of legislation that makes it easier for the arbitration of patent disputes. At this stage it seems far from clear as to what direction things will move; while many questions have been raised, solutions are as yet hard to find. However, it is clear that expedited procedures for settling IP disputes out of court such as expedited arbitration and the introduction of post-grant opposition and/or review procedures at IP offices are mechanisms for settling disputes that seem particularly appealing to inventors, researchers, entrepreneurs and SMEs with limited financial resources. In addition, fast and efficient procedures for disputes in courts are also necessary to ensure that SMEs may rely on the courts whenever necessary.

Conclusions

The "knowledge economy" has brought about structural changes to the economies of OECD countries making it indispensable for companies and policy-makers to address new challenges. One of the most crucial challenges faced by firms is how to manage their knowledge and innovation effectively in order to make maximum benefit from the innovative and creative capacity of the firm. Intellectual property rights have emerged as a useful tools for managing innovation and resolving some of the market failures faced by innovating firms. It is, therefore, increasingly important for entrepreneurs, researchers and business consultants to have a good understanding of the IP system in order manage effectively a firm's intellectual assets.

In the current context, new technology-based firms (NTBFs) are not only more numerous than in the past (especially in high-tech areas such as biotechnology, software and other sectors) but also play an increasingly important role as innovation agents. Evidence from a number of OECD countries show that SMEs, including NTBFs, are not always able to use the IP system effectively and often face a number of obstacles including limited knowledge of the system, high costs and lack of adequate legal, business and technical support for developing a successful IP strategy.

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[27] On the Lambert Review, see http://www.lambertreview.org and the university guidelines are available at: http://www.patent.gov.uk/about/notices/manip.

[28] On this issue, see activities of WIPO's Arbitration and Mediation Center at http://arbiter.wipo.int.

[29] European Commission, *Enforcing Small Firms' Patent Rights* (2000)

[30] European Technology Assessment Network, *Strategic Dimensions of Intellectual Property Rights*, (1999)

Efforts to redress the situation have sought to address some of the specific challenges currently faced by SMEs. A number of experiences have brought about interesting results and should be studied in greater detail to understand the extent to which they may be replicated elsewhere. However, it is argued here that a more concerted effort is required from all institutions operating in the national innovation system to ensure that IP is adequately incorporated into the broader framework of support for SMEs. In doing so, institutions should take into consideration the main obstacles by SMEs not just in applying for IP rights but throughout the IP management cycle, including the commercial exploitation of IP rights, the use of patent databases, the valuation of IP assets and the enforcement of IP rights.

ANNEX: SUMMARY OF THE FIVE CLUSTER CASE STUDIES

Case 1: Prefabricated log homes and complementary product (Western Montana, United States)

Description

Genesis: During the Great Depression (1930s) the Civilian Conservation Corp (CCC) was established by the US government to create jobs and teach skills, and one place it operated was in the Rocky Mountain forests. When the CCC wound down in 1938, a few entrepreneurial corpsmen discovered a market in log homes. In 1946 National Log Construction established a milled log home company in the state of Montana, which generated new markets and businesses and ultimately expanded in size.

The heart of the log building cluster is Montana's Bitterroot Valley, which traverses the length of Ravelli County in the south-eastern part of the state. Other log home builders, post and pole companies, furniture builders, and suppliers, however, are scattered throughout the densely forested Rocky Mountains from the Lake Flathead region 100 miles to the north to Bozeman 100 miles to the west. The largest concentration of this sub-cluster can be found along I-93, sometimes called "Log Home Alley." From 1988 to 1998 production more than doubled in constant dollars (boosted by 37 new companies between 1993 and 1998) and has held its own through the recent recession. The value added to the finished product is about three times the cost of raw wood. In Ravelli County, despite the reductions in logging activity on national forest land, 75 percent of all of its manufacturing employment is in lumber and wood products.

The companies operate as a high value added cluster within the state's and more general forest products sectors. This includes loggers, sawmills, paper mills and other value added wood manufacturers. Log homes can be seen in the assembly stage all along that route. The cluster consists of 45 primary home builders, nearly all of whom are locally owned and small or mid-sized, and more than 40 companies that make compatible structural parts such as doors, beams, windows, staircases, gates, and roofs plus log and other western-style furniture.

Institutional stakeholders include various educational institutions. The School of Business at the University of Montana in Missoula conducts economic and marketing studies for the cluster and Montana State University at Bozeman's agricultural and engineering colleges support process development, testing, and management. The Montana School of Log Building located in Three Forks west of Bozeman is now 25 years old. The school trains people in construction methods and businesses operations. The engineers at the Montana Manufacturing Extension Center located at Montana State University assist manufacturers with a range of technical and organizational problems.

Key features

This cluster has not yet been targeted by any cluster policy, although such a policy is now under development as the result of a cluster study conducted in 2003. Past policies have been driven more by traditional sector policies, some of which have involved government support. Innovation, however, has come from entrepreneurial owners and workers, not research institutions.

Innovation: Despite large federal investments in research from the US Department of Agriculture, the main source of innovation has been the entrepreneurs within the cluster. As early as 1972, an entrepreneur (Alpine Log Homes) reinvented the cluster by finding a way to use more authentic Montana handcrafted logs. His innovation was to prefabricate niche log homes out of these rough, and longer than standard, logs in modules at a single site, disassemble and ship them, and reassemble them on site. He developed the techniques, codebooks, engineering standards, and chinking methods. This innovative company proved to be a wellspring of entrepreneurship as employees left to start other new companies in Montana. Other innovations are embedded in the artistic content and customized nature of the product. Specialty suppliers such as Artisan Doors are able to supply individually designed doors.

Social Capital: In a close knit community liked the Bitterroot Valley, "everybody knows everybody" in the industry. As one owner said, "we used to think we were all enemies… now the best thing about our organizations are in learning what someone else is doing and what may be beneficial to you. [we] still compete but understand the value of cooperation". Another owner said "it just helps to talk to other people about problems and possible solutions". Sawmills develop long-term network-type relationships with loggers, loggers with haulers, and log home builders with design and engineering firms. Most of the association occurs when the local development agency organizes workshops or through chamber of commerce events, in association-sponsored events. In the Bitterroot Valley, for example, a "leads" group of business people meets semi-monthly and exchanges business leads and information and looks for networking opportunities.

Suppliers: Access to raw materials and supplies are important elements of this cluster, largely because the costs of transporting lumber are high and the use of native materials contributes to a form of regional branding that can increase a product's market value. The proximity of the lodgepole pine forests and logging is in part why the cluster developed in Montana. Timber harvests from federal, state, and private lands represent the state's most important asset. In 1998, 71 percent came from private lands, 26 percent from public lands, and 3 percent from tribal lands. Sources of lumber have been shifting over the past decade from public to private lands. This marks a drop from 44 percent in 1976 and 1988 and 31 percent in 1993. Total harvests also have decreased sharply—from 1.2 billion board feet in 1988 to 1 billion in 1993 and 962 million in 1998. House logs and pulpwood relied the heaviest on public forests, with 50 percent and 57 percent respectively taken from federal and state forests. In 1993, for example, 83 percent of pulpwood came from public lands.

Design and engineering freelancers and companies comprise another important part of the supply chain. Although the larger firms have designers and architects on staff, most companies rely on regional expertise to contract their design work. Nearly all firms contract out the engineering review of the designs to local people. The chinking material and technology also is particularly critical to this cluster, and local technical sales representatives work closely with the builders, including training workers in the application.

Transportation: Transportation is vital to the movement of very large products from raw logs to disassembled log homes. Good roads must also be maintained and finding and acquiring the high quality logs needed can be an expensive process, even given the proximity to forests. Much of the best timber is deep in the forest with no road access. The harvesting of logs in Montana often (about half) requires helicopters to get them to a road access point, and then they have to be moved by truck. Logs are also purchased from Canada and trucked south to the prefabrication sites. Fortunately, Montana has a good road system, but transportation adds considerably to the cost of the raw materials. The costs of transporting the completed homes to the customers' building sites is also high since about 86 percent of log homes are sold out of state.

Labour and skills: The cluster has low entry requirements for formal education. As in most clusters, companies look for people with some experience or who are mature (over age 25) and committed

to learning the business. Relevant educational credentials are not considered very important, perhaps because programs that award them are rare or because the educational requirements are more easily learned on the job. However, this does not mean that the work does not require good basic, analytical, and problem solving skills. As the tasks become more selective, mechanized and computerized, employees need technical skills plus certification as an Accredited Logging Professional, which has to be maintained annually. Some of the new entrants do have some college education but usually not explicitly linked to the cluster.

Results to date

Since there is no systematic "programme", only the results of certain interventions can be described. The Montana Manufacturing Extension Service, the Agricultural Extension Service, and the University of Montana Business School have all helped individual companies in various ways—the first with direct assistance to companies, the last with research and information about markets and the industry, and the agriculture extension service with some of both.

The Montana Logging Association, which conducts employee accreditation workshops, has formed a joint task force with the University of Montana at Missoula's College of Technology to identify the new skill needs and develop a Western Montana Logging Program for incumbent workers. The tentative plan is similar to the national Regional Skill Alliance program, where groups of companies select employees to be trained along with employees of other companies. Each module of training will result in a certificate of completion, which will accumulate toward a recognized industry credential. The content will include basic skills including computers and electronics, knowledge of wood species and economics, forest stewardship, use of special equipment including hydraulics, diesel, computers, and fire fighting

The most important cluster-based initiatives, however, are still on the horizon as the state begins to implement the plan for the cluster completed in May 2003. The first steps will focus on improving targeted education and training and on forming a leadership council to assume responsibility for identifying issues and setting priorities.

Factors that have contributed to success

Capital is available and local banks seem to understand and appreciate the industry, participate in their associations, and are able to meet most of the demands for venture and working capital. One owner assured us that "we've always used the local bank and they've never failed to help us." Another said "local banks have assisted this family business for more than 60 years." Not all got the same response though. One owner of an expanding company in the Northwest rated capital as very, very tight and hoped that as the economy improves access will ease.

Since incomes are high and the work lends itself to entrepreneurial and creative people, it is an attractive career. Workers can often find more innovative ways to achieve a desired outcome. As one manager said, "everyone [who works for us] is some sort of artist in his own right. As in many parts of the country, work ethic is a problem when hiring young people. They lack the appropriate attitude to deal with customers, don't understand the business context."

Difficulties faced

Global competition: Nationally, the manufacture of furniture has seen a precipitous decline (more than 13 percent in employment in 2001-2002), due in large part to competition from China—which has built more furniture plants in the last three months than the US has in the past ten years. Yet Montana may be in better shape than most other states to survive and even grow because it has developed and maintained advantages in certain niche markets related, for example, to an outdoors, recreation-oriented, and rustic

frontier-style design. The state also has a large regional market for agriculture related needs in both custom and mass-produced products for homes, ranches, and farms.

Access to raw lumber: This is the biggest problem the industry now faces. Logging activity in the forests in and around the Bitterroot Valley fell by more than 50 percent between the 1980s and today, in part because the earlier level could not be maintained without degrading the forests. The companies now purchase about 90 percent of their raw lumber from Canada.

Labour shortages: Despite the available labour pool, there are selected shortages of certain skills – such as workers who know how to program, modify, and repair computer numerically controlled equipment that is being used by an increasing number of companies. When equipment breaks down, according to one owner, "considerable time is lost waiting for qualified repair personnel – who sometimes have to be brought in from Canada". Another skill that requires higher levels of education is AutoCAD and the 3D versions.

Some of the lumber goes directly to log home manufacturers. Other ingredients used in the final products include chinking materials, sealants, paints and finishes, bolts or spikes, metal hinges, fasteners, and stampings. Adhesives and sealants tend to be more standardized and more easily purchased from anywhere in the world.

Unpredictability of raw materials supply: One challenge named most often is the reduction in and unpredictability of the supply of timber from the state. It affects the logging companies and mills most severely because the sectors that use wood can purchase from Canada or Idaho, although it become less convenient and sometimes more costly to do so. The unpredictability also makes it difficult for companies to make capital investment decisions and modernize.

Outlook

While the State of Montana has long recognized the contribution of the industry to the state's economy and "brand", in 2003 Montana officially recognized it as a specialized part of a larger wood products cluster. This is leading to a process for organizing private sector (mainly SME) leadership and more explicit policies to address certain needs. The following strategies are being mapped out for the cluster:

- *To establish a one-stop resource centre for the cluster*. The Center would be a storehouse of information and act as broker to other agencies that meet particular needs.

- *To organize learning and training networks.* Since small firms in any industry rarely are able to support training, a common, cost-effective solution is to organize training for groups of *employers.*

- *To establish branding and a Montana Design Center.* The combined creativity, experience and knowledge of artists and wood crafters working together to create a distinctive high quality brand style could be the key to forging an easily-marketable niche for Montana products.

- *To create a competitive research and innovation grant program to identify new uses or markets for forest products.* Such a program might be used, for example, to find new uses for small diameter wood or to find niche markets. This program may be best managed by a university but must have a simple application process, with peer review by industry people, not academics, to attract companies and non-academic individuals.

- *To make Montana parks, roads, and tourism offices showcases for Montana wood.* Logs should be the standard for state supported buildings related to tourism and the interiors should reflect the best of Montana art and design.

- *To incubate new creative wood based enterprises.* Incubators can provide low cost space to develop a product and process within a supportive environment among firms with similar interests and possibly similar markets.

Summary and Key Lessons

This cluster, though relatively small, is important to the state of Montana because of its potential for expanded markets associated with growing interest in vacation homes in the US and a distinctive state brand. While companies produce log homes in many parts of the US, Montana has developed the highest concentrations and strongest reputation. Although the cluster has developed with minimal public sector support – as have most successful clusters around the world – the state now realizes that it has the ability to catalyze faster growth with selective interventions.

Case 2: Biotechnology and life sciences in the Research Triangle Area (North Carolina, United States)

Description

Genesis: The Council on Competitiveness's study of Innovation Clusters in the Triangle area identified what it called a pharmaceutical/biotechnology cluster as among its most competitive. It was the sixth largest such cluster in the nation when the Council gathered its data in 1999, with a critical mass of research and clinical testing. The Council traced the cluster's origin to 1959 when Chemstrand purchased land in RTP for its corporate laboratory and the first expansion in 1965, when the National Institute of Environmental Health Sciences also chose RTP for its location. The first large private tenants were Burroughs Wellcome and Glaxo in the 1970s.

The decisions of Burroughs Wellcome to relocate a production facility from New York to Greenville in 1970 and to open its first R&D facility in the Research Triangle Park in 1971 established the anchors of North Carolina's biotechnology industry. Even before the production of the first monoclonal antibodies for diagnostics in 1982, leaders in North Carolina identified biotechnology as an area of science and technology with rare potential to create both economic opportunity and a higher quality of life. In 1981, those leaders created the North Carolina Biotechnology Center (NCBC), initially as a state agency and later, in 1984, as a private, non-profit corporation. The Center was intended and developed as a neutral, non-partisan organization that helps industry, academia, and government pursue biotechnology opportunities productively and efficiently. The Centre's mission is to provide long-term economic benefit to North Carolina through support of biotechnology research, development and commercialization state-wide.

North Carolina's biotechnology industry is highly concentrated in the Research Triangle Area, where 16 of the state's 31 bio-manufacturers are located. The Triangle is also home to 57 contract research organizations and 99 other biotechnology companies that mostly engage in research and development. In addition, a number of specialized suppliers of products and services are located in the Triangle. In 1999, the Research Triangle Metropolitan Statistical Area (MSA) had 14 554 employees in the pharmaceutical/biotechnology cluster, making it the eighth most concentrated MSA of the 30 largest clusters in the United States. From 1990 to 1999, the Research Triangle's pharmaceutical/biotechnology cluster had an annual growth rate of 6.4 percent, the fastest among the 20 largest MSAs. Over the past five

years, North Carolina's biotechnology industry has grown at an annual rate of 15 percent and created an average of 2 000 jobs each year across the state.

Institutional stakeholders in addition to NCBC include the Triangle's major research universities – UNC Chapel Hill, NC State University in Raleigh, and Duke University in Durham. All three universities play an important role in technology transfer and have spun out a number of biotechnology companies over the past decades.

Key features

NCBC and the Council for Entrepreneurial Development are frequently cited as important to the cluster's success, because they link biotechnology firms to research and talent inside universities and give them access to business knowledge and venture capitalists. NCBC has five main corporate goals:

- Strengthen North Carolina's research capabilities in its academic and industrial institutions.
- Foster North Carolina's industrial development.
- Inform and educate the public about biotechnology.
- Develop mutually beneficial partnerships among all parties involved in moving biotechnology from research to commercialization.
- Establish for North Carolina a leadership role in biotechnology and its commercialization.

Results to date

Since its creation, NCBC has invested more than $50 million to improve the biotechnology research capabilities of the state's universities, including recruitment of 46 outstanding faculty, purchase of multi-use research equipment, sponsorship of more than 450 research projects, and support of intellectual-exchange events. It has helped to triple enrolment in the biosciences at the state's six historically minority universities by investing $8 million in the institutions' biotechnology programs. It has created the North Carolina Genomics and Bioinformatics Consortium, a partnership of more than 70 universities, companies and non-profit institutions working to advance these fields in the state.

The Center has provided $8 million in early financial assistance to 62 small biotechnology companies, which have gone on to raise $460 million from other public and private sources. It has created the $26 million North Carolina Bioscience Investment Fund to provide venture capital for new biotechnology and related bioscience companies. The Center has also worked to recruit, retain and expand biotechnology companies including BASF, Bayer, Biogen, Diosynth RTP, KBI BioPharma, Novozymes, Schwarz BioSciences, Sygenta, and Wyeth Vaccines.

During these years, North Carolina has made dramatic strides in R&D funding related to biotechnology, ranking 7th in the nation in funding from the National Institutes of Health in 2002. It was ranked 9th in the nation in 2002 by the National Science Foundation funding for biological sciences.

Similar progress has been achieved in the biotechnology industry, where North Carolina companies received over $766 million in venture capital investments from 1995-2002, ranking 5th in the nation. The state ranks 6th in pharmaceutical and medicine manufacturing employment, 15th in physical, engineering and biological research firm employment, and 7th in the total number of Ph.D. life scientists in the workforce.

Factors that have contributed to success

North Carolina universities spend well over $1 billion on research and development annually. Approximately 57% of that amount is funded by the federal government, 10% by state or local governments, and 15% by private industry. The remainder is either self-funded or funded by other sources. Duke University, UNC-Chapel Hill, and NCSU have spun off a number of companies over the past decades, including Quintiles and Trimeris. The three universities have also issued hundreds of licenses.

The presence of major pharmaceutical companies in North Carolina has fostered entrepreneurial activity and start-ups. For example, 15 successful start-up companies have spun out of GlaxoSmithKline between 1970 and 2000, especially after mergers, acquisitions, and reorganizations resulted in layoffs.

Difficulties faced

A dramatic increase in competition: Nationwide, biotechnology has become the most sought after prize in economic development. As of 2001, 41 states had life science initiatives underway, with ten of those creating biotechnology or life sciences strategic plans between 1997 and 2001. Sixteen states are using their tobacco settlement funds for bioscience-related R&D; three are using tobacco funds to improve technology transfer and commercialization. Twenty-eight states have one or more publicly supported seed or venture funds that can invest in biotech. Five states have funds that invest exclusively in biotech and life sciences. Twenty-six states have research parks housing bioscience companies; nine of them have parks focused exclusively on bioscience.

Traditional domestic biotechnology powers such as Massachusetts and California are continuing to make new investments to solidify their leadership. They have been joined by a wave of newer contenders pursuing aggressive initiatives involving both public and private funds.

North Carolina also faces stiff competition abroad, where numerous countries have made biotechnology investment a lynchpin of national economic strategies. Established players in the industry such as Ireland, France, and Germany continue to focus on growth and diversification through investments in research, seed funding, and loan guarantees.

Social and ethical issues: Ethical and social issues arise from the research and production of biotechnology products. Consequently, the public has a say in the regulation of the industry. Especially if state funds are involved in choosing industries or funding high-profile research, policymakers must be prepared for the challenges of an electorate very concerned with the impact of biotechnology on their lives.

Training and education: While North Carolina can match the current training needs of new or expanding biotech industry, it still has room for improvement – as many employers have pointed out – and in fact must continue to improve and innovate or risk being overtaken by competitors around the world. Since the markets and competition for biotechnology are global, being best in the US is not enough to ensure long-term success. North Carolina and the US compare well against other nations in terms of customized training and highly skilled workers, but neither does well in the mid-skilled workforce.

The community college system, while internationally recognized as a benchmark workforce development system, receives only about seven percent of the state's education budget and is under-funded. Many states have surpassed North Carolina in support of both credit and business and industry programs. Community college faculty earn, on average, far less in North Carolina than in other states with biotechnology initiatives.

As it stands, too many entering the postsecondary systems and the workplace need remedial education. Half of those starting community college programs require remedial education. Also, too few

students are completing programs for biotechnology-specific occupations. Perhaps because of inadequate marketing, daunting standards, or insufficient existing employer demand for the degrees, students are not completing less-than-baccalaureate courses of study in biotechnology related fields.

Barriers to entrepreneurship: At least three issues impede entrepreneurial growth and biotechnology start-up activities in the state. First is the issue of scale. Because of their size, Boston and San Francisco are home to more biotechnology start-up companies and more venture capital firms than the Triangle and North Carolina as a whole. There are also more patents issued in these larger metropolitan areas.

Second, compared to these leading areas, North Carolina has relatively poor infrastructure and support systems such as laboratory space, research and development assets, and particularly direct airline flights to and from major biotech destinations. Most assets of this kind are highly concentrated in the Triangle. Third is the need for a larger talent pool of entrepreneurial executives, managers, and founders with the skill sets and the experience to grow start-ups into successful, viable companies. There is a perceived lack of business leadership at the emerging business level in North Carolina.

Summary and key lessons

This cluster is important to the state of North Carolina not only because it is one of the largest and fastest growing biotechnology clusters in the US, but also because of its potential to create opportunities for biomanufacturing activities outside the Triangle. The commercial development of the life sciences industry in the region and the state has proved to be an important alternative to the region¹s traditional durable goods manufacturing base. The life sciences industry also retains a knowledge-based workforce and increases the average income of the Triangle residents at a time when other technology sectors are downsizing. While there is broad support for the cluster in the Triangle region, increasing national and global competition for human and capital resources creates a serious challenge that requires strategic commitments by higher education, government, and the life sciences industry itself.

Case 3: Cluster policy in a transition country; the ACS Cluster Initiative (Slovenia)

Description

Despite Slovenia's macroeconomic success, the Minister of the Economy, Tea Petrin, recognized that the country faced obstacles to sustainable growth in the long term. The economy was still dependent on traditional industries with low value added and productivity was more than three times lower than the EU average. Minister Petrin determined that supporting the development of cluster initiatives would be one of the most effective ways to upgrade the Slovenian economy.

The program began in 1999 with extensive surveys and analysis to identify networks and relationships within the economy. ITEO, a Slovenian consulting firm, conducted the analysis in four phases. The first step was to agree on working definitions. For the purpose of the mapping study, potential clusters were defined as product/service systems that had a potential of developing into internationally successful clusters given suitable coordination by government, firms, R&D and support institutions. Second, quantitative analysis was used to identify the leading industries for each of the 12 statistical regions based on industry codes and the limited available statistics. Third, the qualitative portion of the analysis followed to identify links between companies and between companies and universities, R&D institutions and other support organizations. Links were observed within regions, between regions and internationally. The final step was to identify innovative systems, which were seen as potential clusters. Product and service systems were identified in terms of innovative potential through a review of factors of innovation such as patents, employment in R&D departments and export orientation.

The survey revealed that enterprise cooperation and networking were weak and the infrastructure required to support cluster development was only beginning to emerge. The primary conclusion was that "currently there are no clusters in Slovenia." Nevertheless, ten potential clusters were identified: electric-optical, automotive, household appliances, construction, transport, information technology, furniture, textiles, tourism and pharmaceuticals.

In early 2000, the Ministry of the Economy issued a tender inviting prospective clusters to apply to receive government assistance for developing and implementing cluster strategies. Support for clusters was limited to three pilot projects, so the Ministry could gain knowledge and experience in the area of cluster development before a large program was launched.

Applicant clusters were required to submit a detailed action plan for one year and five-year strategic plans. The vision of the project leader weighed more heavily than his/her experience. In accordance with the bottom-up philosophy, the government did not evaluate the merits of cluster vision statements. The criterion was consensus of a common vision, not the particular vision itself.

Lack of understanding of the cluster concept was recognized as a hurdle, so there were outreach and education efforts. The tender document included a description of what clusters are, why they are important and what the results can be. OECD organized seminars on clusters and a key person from each cluster participated in a committee, where the cluster concept was discussed.

Two of the identified potential clusters applied and were selected – automotive and transport. The tool making cluster was originally seen as a subset of the automotive cluster, but was able to successfully distinguish itself in its application and was selected.

The government provided financing for the pilot clusters for one year renewable for a second year. The companies were expected to contribute 60% of related costs; the government paid 40%. There was a fixed tariff set for salary time, which was used for calculating the contribution of labour. Clusters annually submitted budgets and documentation of all expenses.

Although the government financed the cluster, it was not directly involved in the specific planning or activities of the clusters. The process was intended to be "bottom-up," with all authority and responsibility resting at the firm level.

In 2002, the Ministry issued a second tender for clusters. Out of 15 applicants, eight new clusters were selected to receive government co-financing.

Automotive Cluster of Slovenia (ACS): A strong automotive parts industry developed in the protected Yugoslav market. During the socialist era, manufacturers were prohibited from importing cars that did not have Yugoslav components. As Slovenia was the most industrialized republic, most parts manufacturers were located there. The companies were generally large and adapted well to the new post-independence competitive environment. The companies tended to have narrow specializations, primarily producing niche automotive components for the German automotive industry. With the exception of car batteries, no large company had a direct competitor within Slovenia.

The cluster initiative began in 2000 with seven companies and three institutions. According to one founder, at that time they did not even know what a cluster was and organizing the companies was difficult as there was significant scepticism about this type of cooperation. Cooperation in the past had been political, not economic. Enthusiasm and dedication from younger staff, who were more open to cooperation, was fundamental. The group contracted Mateja Dermastia, who was then working for the Center for International Competitiveness, to help with their proposal to the government for funding. A generalized opinion was that "Without Mateja, we would not be successful."

Key features

As of spring 2003, ACS comprised 22 companies and 5 research institutions and faculties. The cluster employed a full-time director, full-time project coordinator and part-time advisor.

The Supervisory Board consisted of five members elected by the Assembly: one from a university or institute, two from large companies and two from small companies. Each company had a coordinator who participated in monthly coordination meetings. In practice, this group functioned like an advisory council.

Annual fees were EUR2 000 for large companies, EUR1 000 for medium-sized companies and EUR500 for small companies and R&D institutions. There was also a one-time entrance fee of 25% of the annual fee. Voting rights in the Assembly were proportional to fee contribution.

The vision of the cluster was defined: "The main goal of ACS is to become the system supplier to global car producers at special segments with complex products with high added value."

Activities of the cluster were grouped into six areas:

- Promotion: trade shows, catalogues of cluster members and their products.
- R&D/supply chain development: common purchasing.
- Cluster infrastructure development: database for information on R&D activities, human resources and capacity sharing opportunities.
- Intranet for sharing information on technology, knowledge, products, engineering problems, etc.
- Education: seminars and conferences on industry trends, presentations by speakers from abroad, such as the supplier director of BMW.
- Quality and business excellence.

Results to date

The interviewed counterpart was hesitant to name specific successes while the program was still in the pilot phase, but he pointed to the fact that individuals across the industry had started to talk to each other and learn about each other's capabilities. ACS kept costs down, used funds efficiently and held a series of successful seminars, most of which were attended by over 100 people.

Companies in the industry recognized that becoming system suppliers was a market imperative. A large company representative indicated his desire to cooperate with core suppliers in order to provide complete systems. For this objective, he said, information sharing was the most important activity as "it is better for companies to pool their knowledge and resources together than to compete with each other." Any single company was too small to master all the technology, but together they could be faster to market than their competitors elsewhere in Europe.

Small companies found that access to markets and common promotional activities were especially valuable benefits of cluster membership.

The membership of the cluster did not include some of the largest and most important companies in the industry such as Revoz-Renault, Prevent, Saturnus and Sava Tires. These companies had already established networks with suppliers and universities themselves and did not see the value of ACS. While ACS would have liked to have these companies belong, they recognized that membership was voluntary and each company decided for itself whether to join.

Most of these companies, however, were members of the Slovenian Automotive Component Manufacturers Association (referred to as the "Klub"). This group was formed shortly after independence to lobby the government for temporary protection from imports. Its success in this area led to more cooperation, such as attending international fairs together. Other activities included a common catalogue, educational programs and organized visits by foreign car manufacturers to Slovenia. Joint research projects have occurred among members of the Klub, but these were sporadic and not planned by the association. The Klub had 36 members. Its fees were EUR250 plus volunteer work. At fairs, the attendees pooled all the expenses and split them evenly. The Klub's president asserted that companies joined ACS in order to have access to government money, not out of dissatisfaction with the Klub. In fact, some companies were members of both.

Case 4: Digital Media and Creative Industries Cluster Initiative (Scotland, United Kingdom)

Description

Scotland's economic history is rooted in traditional industries. To a large extent, the Scots' popular image of their economy has been, until very recently, conditioned by this traditional background. A "real" job is one in which something is manufactured. A "real" business produces useful physical products. The powerful engines of the national economy were large companies and corporations with large workforces and long-term stability. Whilst the late 20th century shift towards service-oriented businesses and smaller-sized enterprises applied just as much in Scotland as anywhere else, the popular psyche remained wedded to the old industrial models. Alongside this rather old-fashioned industrial paradigm, Scotland has always maintained a very high respect for education, innovation, cultural life and the spirit of enterprise.

Over recent decades and most particularly since 1991, Scotland has also maintained a national effort led by the public sector to develop its economy pro-actively. In 1991, two major agencies involved, the Scottish Development Agency (largely concerned with physical infrastructure) and the Training Agency (focused on skills and workforce development), were combined into a unified agency, Scottish Enterprise. This new agency had an extraordinarily comprehensive remit to develop the Scottish economy across a broad spectrum: from workforce to company development, from physical to research infrastructures, from indigenous development to globalisation and internationalisation.

In 1993, Scottish Enterprise worked with the Monitor Group to identify which industrial sectors were particularly key to the future prosperity of Scotland so that appropriate priority could be given to them. By 1997 this project had matured into a major implementation of economic development along cluster lines, with clusters defined as identifiable groupings of the economic base where global economic advantage and competitiveness could be built by improving the inter-linkages and collaborative mechanisms between firms and the other economic entities with whom they were functionally interdependent. The first four target clusters were identified as oil and gas, food and drink, tourism, and semiconductors. Initiatives were launched in all these areas.

At the same time, Scottish Enterprise was continuing its work with other key industries with a single-sector rather than a cluster approach. One of these industries was filmmaking, which was prompted by losing to Ireland a large part of the making of the Mel Gibson feature, "Braveheart" about William

Wallace, an iconic figure from Scottish history. As a result of the film initiative, a public-sector body "Scottish Screen" had been set up to complement local support services, such as the Glasgow Film Office. At the same time, multimedia began to emerge as a subsection of the software industry with potential for its own focused development. It was realised that there are considerable synergies and overlap between multimedia and film, in terms of innovations in digital film, animation and on-line video. It was further conjectured that other industries might be similarly "clustered" with film and multimedia as a result of convergence in business models as well as technological convergence.

A basket of industries was identified as possible components of a meaningful cluster, which acquired the name "creative industries". This immediately provoked protest from other industries. If these were "creative" industries were all other industries therefore "uncreative"? It was pointed out forcefully that creativity is vital to all industries. This apparently esoteric discussion actually led to a useful definition of "creative industries," which has been applied in Scotland. Whilst creativity is undoubtedly essential in all industries, most of the time it is harnessed as an agent of change or improvement. A factory does not grind to a halt because nobody had a creative idea today. By contrast, printing presses certainly would fall idle if nobody could think of a new newspaper article or book manuscript. Studios would be empty if nobody could think of a new screenplay. In other words, there are a set of industries in which the fruits of human creativity are a primary raw material to the business process rather than just a source of change or improvement. The industries in Scotland which conform to this "creativity as raw material" model are: music; design (including fashion design and crafts); publishing; new media (including multimedia and Internet); computer games and packaged leisure software; films; broadcasting (including TV and radio); advertising; architecture; and cultural industries (museums, art galleries, antiques, etc.).

The cluster: Because these industries had not previously been considered – anywhere in the UK – in light of their creative elements, the Standard Industrial Classification (SIC) coding structure by which all UK economic activity is monitored and reported, did not accurately map the creative sectors. For example, measures of employment in the film industry aggregated all the ancillary employment in the physical production of film stock and cameras, processing negatives and the production of the necessary chemicals, etc. The first job of the Scottish Enterprise cluster team was to form new estimates of the creative elements of these industries. Whilst this could not be done with absolute rigor, consultation with all available stakeholders, including the Central Statistical Office of the UK government, yielded a broad estimate, which was considered by all concerned as sufficiently robust to be useful. The Scottish creative industries cluster is estimated to add approximately £5.3 billion per annum (4%) to Scottish GDP and support around 70 000 full-time equivalent jobs. By any standards, this makes the creative cluster a substantial element of the Scottish economy, fully comparable with electronics (45 000 employees) and whisky (55 000 employees).

As mentioned above, most of these industries had not previously been explicitly targeted for economic development, so the early stages of engagement primarily aimed to establish contact and promote communication, both between creative sectors and Scottish Enterprise and among the creative sectors themselves. Scottish Enterprise was gratified to find a highly enthusiastic response from the industries themselves, who were keen to explore collaboration opportunities, primarily related to technological innovation. As the Edinburgh-based publisher Canongate told Scottish Enterprise, "…we notice that in our contracts with authors, we are buying all sorts of additional rights to electronic publication, but we have no idea how to make use of those rights. We would like to talk to someone in the games industry or a web designer." Two hundred representatives of creative companies at a plenary symposium in 1999 were asked, "If there were one single thing that Scottish Enterprise could do to promote the growth of this cluster, what would it be?" Their answer was, "Keep us talking to each other."

Key features

The creative industries cluster initiative was primarily run by the national office of Scottish Enterprise, but with extensive consultation and collaboration with industry representatives. For example, Scottish Enterprise works closely with all the appropriate trade associations, as well as other public-sector agencies such as the Scottish Arts Council.

Importantly, there is strong regionalisation of the cluster initiative, too. The "core team" that formulates and maintains the day-to-day strategy agenda for the cluster is made up of representatives from five of the local enterprise companies in the Scottish Enterprise network, in addition to four members from Scottish Enterprise National. This has led, in some cases, to component sectors of the creative industries cluster being co-ordinated from a local office, in line with regional strengths. For example, Tayside (Dundee), although technically a local office of Scottish Enterprise, provides national co-ordination to the games industry. Similarly, Glasgow co-ordinates design.

Digital media and creative industries development is also a very high priority for the UK government and the newly devolved Scottish Executive. There is, therefore, strong political support for this intervention and on-going co-operation with government, particularly collaboration with the industry departments (Department of Trade and Industry in London, Department of Enterprise and Lifelong Learning in Scotland) and cultural departments (Department of Culture, Media and Sport in both London and Scotland)

Scottish Enterprise is also active outside the cluster initiative via schemes such as the Small Business Gateway (SBG), which provides general support to small businesses. Since a number of creative businesses characterise themselves as artistic or cultural rather than purely commercial, new schemes are developed in partnership with the Scottish Arts Council to provide equivalent small business support, but expressed in more congenial "artistic" language, through a specialised gateway, the "Cultural Enterprise Office." A pilot of this concept in Glasgow has proved highly successful in attracting clients unlikely to approach conventional support agencies. Typically a creative company in Scotland employs fewer than 20 people and turns over less than £200k per annum. However, the CI also includes significantly large players capable of competing effectively in UK and global markets, particularly in computer games, television production and music.

There is not a dedicated, separate office for the creative industries initiative. In general, support and activity are delivered through existing structures and bodies such as Local Enterprise Companies, industry associations and partners such as the Scottish Arts Council.

When the action phase of the cluster intervention was launched in April 2001, the programme had resources of £25 million over a 3–5 year period. The creative industries CI is now one of eight to nine cluster initiatives underway in Scottish Enterprise. There is regular interchange and collaboration with other clusters to monitor areas of opportunity in overlapping industries such as bio-informatics.

The main facilitators of the cluster initiative are the national and local members of the Scottish Enterprise "cluster team" described above.

The shared vision for the cluster initiative is published in a document entitled "Creative Scotland: Shaping the Future" and the CI's progress through 2002 was published in an annual report for the cluster.

Whilst there is strong commitment to this initiative, there is a clear exit strategy for Scottish Enterprise. The aim is to achieve self-sustainable corrections to market failures in order to eliminate the need for further intervention of this type by the end of a 3–5 year period. There is regular evaluation of progress and annual updating of baseline data to track the progress of the cluster. There is long-term

sustainability from the initiative, however, in the enduring products, which will remain from the cluster intervention. These include major infrastructure projects such as the large-scale development of media centres in Glasgow and Dundee, and also the permanent legacy of new and expanded agencies such as Scottish Screen, the Scottish Arts Council and more specific bodies such as the games industry association, TIGA Scotland.

Results to date

To date, the CI has performed well in the four focus areas. Linkages between industry and academia have been improved, and CI activities have generated new spin-offs. Linkages have improved through fellowships for scientists to make room for sabbaticals (to commercialise an idea) and intermediary technology institutes. Penetration of export markets has improved through trade missions and international events. To lure new talent into the cluster special talent events and recruitment fairs have been carried out in Scotland. On the infrastructural side a digital media quarter in Glasgow is under construction and plans cover a new Digital Media Park in Dundee.

Summary and Key Lessons

Both with regard to this case study and case study 3, it is evident that the evolution of a cluster initiative is highly dependent upon the conditions prior to the launch of the programme. Emergence from industry-led projects can create problems with government commitment, and government-led projects can stifle commitment from industry once the cluster initiative is set up. It clearly takes time to build up momentum for a programme, typically more than three years. Financing changes over time with government seed money playing a lead role in the first phase. In later stages government money seems to decrease as a general rule, with membership fees becoming more important. Thus, surviving cluster initiatives move from a project-based organisation to a more membership-based organisation. There is no obvious "path" whereby cluster initiatives move from simple to complex, or from a narrow to a broad set of objectives. Both old and new cluster programmes can have a broad scope.

Case 5: The Valencia Cluster/Network (Spain)

Description

The Valencian Innovation System of Science- Technology- Enterprise (SIV) is broad and complex. The main figures, administrative, scientific and technological, to support the SIV are the following:

- Science and Technology Office.
- IMPIVA, Valencian Institute of Small and Medium-sized Industrial Enterprises.
- REDIT, Network of Technological Institutes of Valencian Region (17).
- 6 Universities (51 Faculties, 7 000 professors, 143 000 students).
- 32 University Institutes.
- 10 CSIC Centres (National Council of Scientific Research).
- 7 regional Research Centres.
- 4 European Innovative Enterprises Centres.
- 4 100 researchers.
- 7 050 workers involved in Research and Development activities.

At the organisational level, the Consellería (regional Ministry) of Innovation and Competitiveness is the Department of the Government with competencies in the field of scientific and technological policy. The Under-secretary of the Science and Technology Office is responsible for the implementation of these competencies, as well as the implementation of PVIDI, according to the 7/1997 Law on Promotion and Co-ordination of Scientific Research and Technological Development of the Comunidad Valenciana.

Key features

The Regional Plan on Scientific Research, Technological Development and Innovation (PVIDI) 2001-2006 has recently been approved. The Plan is structured around two main strategic axes: (i) improvement of scientific knowledge and technological innovation, and (ii) the strengthening of competitive capacities.

PVIDI represents an important effort of co-ordination and prioritisation of governmental activities, essentially oriented to meeting the future economic needs of the Comunidad Valenciana. PVIDI is directed at reinforcing the link between research and innovation. The main objectives of the Plan are the following:

- Improve the excellence and strengthen the competitiveness of the Valencian Science-Technology- Enterprise System.
- Increase the global resources (public and private) dedicated to Research and Development and Innovation in the Comunidad Valenciana, with the aim of reaching 2% of regional GDP by 2006. Improve the efficiency of the distribution and use of these resources.
- Promote the vertical integration, co-ordination and interaction between all agents of the Science, Technological development and Innovation System (University Institutes and Departments, Research Centres, Technology Centres and enterprises).
- Reinforce the transfer of research results, and increase the social and economic profitability of the existing ones, with the aim of achieving the maximum benefit for Valencian society.
- Promote the participation of the private sector in innovation activities as a strategic action of Valencian enterprises and as a key factor of research and technological development.
- Promote public awareness of science, as well as the diffusion and development of a scientific and technological culture in Valencia.
- Co-ordinate the activities of the Regional Government in this field with the national and European activities in the Comunidad Valenciana, enhancing co-operation with other Governments and institutions, both national and international.

In the framework of these general objectives, the new approach of PVIDI complements its activities with those implemented at the EU and national level in the new framework of the European Research Area (ERA). Indeed, the European Research Area and the National Plan of Scientific Research, Development and Technology 2000-2003 offer the context in which a regional R&D and innovation policy must be implemented. For geographical, dimensional and budgetary reasons, an excessively dispersed implementation must be avoided. Concentrating efforts in certain key areas is the way to achieve significant performance in the regional system.

Results to date

As the PVIDI has been structured in some priority areas around three types of Programmes, each one has achieved positive results developing its own key action lines.

- General Knowledge Programmes:
  - General Progress of Science Action Line. These actions have been oriented to increase the quality and quantity of research in all knowledge domains.
  - Innovation and Technology Transfer Action Line. These actions have encouraged innovation as the motor of technological development, transfer of new technologies and orientation of basic research.
  - Information and Knowledge-based Society Action Line. These actions are oriented to support the creation of new enterprises in the IT sector and the encouragement of demand for advanced services.
- Sector Programmes: These actions address specific R&D needs of the different Departments of the Generalitat Valenciana. These actions, which represent an achievement of co-ordination of sector policies and a reflection of a common R&D and innovation policy, are the following:
  - Health and Quality of Life Programme
  - Agro-food Programme
  - Environment Programme
  - Infrastructure and Land Management Programme
  - Culture and Society Programme
  - Socio-economics Programme
- Own Programmes: These actions are proposed and financed by the different Departments of the Government, and are incorporated in the PVIDI when approved.

The other key point related to the success of the programme is the creation of institutions to support the SIV (the REDIT, the RUVIT network of Universities, the European Business and Innovation Centres, PROXI points, and the Office for Innovation Results Transfer).

Factors that have contributed to success

The key factors considered to have contributed to programme success are that there is an enhanced innovation environment. Geographical sectoral clustering has also occurred. Furthermore, Technological Institutes now cover the entire geography of the sectoral clusters. Strong institutions have been created by the Regional Government and there has been an overall increase in innovative actions and projects.

Difficulties faced

The main problems faced have been a lack of innovative services and products companies and a scarcity of private financial support for innovation (venture capital, business angels, etc.). Public actions have been critical. There has also been a lack of interaction and links between all agents participating in the SIV. Overall, there is still a low level of R&D investment in the region, at .62% of GIP, compared with

0.89% in Spain and 1.8% for Europe as a whole. There is also a relatively low level of high technology employment and a limited R&D orientation of Universities regarding industrial needs.

Summary and key lessons

The Valencian Innovation System is rapidly converging with national and European standards in the field. The Regional 7/1997 Law on Promotion and Co-ordination of Scientific Research and Technological Development of the Comunidad Valenciana is the legal framework in which the regional competencies in the field of scientific and technological research are implemented. This legal base represents a significant improvement in Research and Development and Innovation policies, which are key to sustained growth. Therefore, the main purpose of PVIDI is to address the direct and indirect demands of the main technology users in the Comunidad Valenciana, while continuing to support the Valencian Centres and groups of excellence in all areas of R&D and technological innovation. The SIV and the instruments (companies, programmes, etc.) created to support the industry and promote innovation are now producing visible results. These results are being seen not just locally, but also in terms of technology exports and technology transfer to other regions and countries.

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