European Commission

Building an Innovative Economy in Europe

A review of 12 studies of innovation policy and practice in today's Europe

Enterprise Directorate-General

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Executive summary

This brochure summarises 12 reports – the first in a series of Innovation Policy Studies undertaken for the European Commission's Enterprise Directorate-General. Nine were commissioned to examine the trends and impacts of European innovation policy, or to shed light on specific aspects of interest to policy-makers – many make use of the unique dataset about firm-level innovation activity in Europe assembled by the Community Innovation Survey. The other three assess specific actions addressing respectively the financing of innovation, the promotion of innovation management techniques among small and medium-sized enterprises (SMEs) and the development of regional innovation strategies. All serve to improve understanding of the dynamics of European innovation – its mechanisms, its strengths and its bottlenecks. They therefore reinforce the ability of regional, national and EU policy-makers to develop Europe's innovative capacity with legislation and support measures that are effective, appropriately targeted, and mutually reinforcing.

The topics addressed here are diverse. The reports summarised are the outputs of separate studies by different independent research teams. Yet a number of key messages emerge from this material with a degree of consistency that is striking.
First, **innovation is ever more important** in today's increasingly global, increasingly knowledge-based economy. Competitiveness depends, to a far larger extent today than in the past, on the ability of manufacturing and service sectors to meet fast-changing market needs quickly and efficiently through the application of new technology. This capacity to assimilate and apply new knowledge in order to improve productivity and create new products and services relies on scientific inventiveness and entrepreneurial flair. But it is also affected fundamentally by the conditions which permit, encourage and sustain innovative creativity and investment, or which impede and limit it. In the 21st century, innovation will be the primary driver of successful industrial and enterprise policy, but must also inform policy in areas such as education, employment law and taxation.

Second, **innovation is pervasive and diverse**. It does – and should – take place in firms of all size, in every region and in every sector, not just in 'naturally innovative' high-tech sectors such as biotechnology and information technology. These emerging sectors are crucial as engines of economy-wide innovation, and *may* be crucial as sources of future employment, but today still account for a relatively small share of the European Union's GDP. Innovation policy which focuses exclusively on high technology therefore risks missing the much larger opportunities for improved competitiveness and new products and processes in more traditional industries, which remain the EU's major employers. New knowledge is not only created through research and development. It is also acquired as a result of investment in plant and machinery, and through human resources development. Even in the high-tech electrical and electronic equipment sector, R&D expenditure only amounts to 27% of overall investment in innovation.

Although pervasive, **innovation is unevenly distributed**. The innovation performance of Member States, and of different regions within individual Member States, varies very widely. More specifically, the innovative capacity of industry is highly skewed towards larger firms. There is a growing number of nimble and dynamic technology-based European SMEs. Many are making a vital contribution to technological progress, are achieving great success in international markets, and are growing rapidly. But these cases cannot mask the fact that the innovative capacity of most technology-using SMEs remains weak. SMEs tend to lack both the internal resources and the external networks necessary for easy access to the knowledge, skills, technologies and finance on which innovation depends. Furthermore, technology-oriented SMEs are disproportionately affected by many institutional barriers and costs – for 49%, fear of the cost of patent-defence litigation is a significant deterrent to investment in invention, for example.

Fourth, **innovation is systemic** rather than linear. That is, the processes of innovation are multidimensional. They involve many different players, and often take place over extended periods of time. Successful innovation *may* entail a transfer of technology – for instance, from a university or research centre to a company – but this is rarely an isolated event. The speed and the success of the transfer almost certainly depends on other interactions, before and after the transfer itself, and is heavily influenced by conditions in the local and national 'innovation environment'. Innovation therefore requires the development, over time, of highly interconnected systems. Well functioning innovation systems in particular serve to ensure the free flow of information across the interfaces between large firms, researchers, entrepreneurs, investors of all kinds, consultants, patent agents and other intermediaries, local authorities and other actors. Such systems *may* have technical components but are, above all, networks of individuals. Proximity is an important feature of most innovation systems, and policy-makers rightly devote resources to attempts to create self-sustaining local and regional innovative clusters, often in science parks centred around universities or large multinational technology firms. 'Vertical' interconnections are also vital – for example, linking business angels, banks, venture capital funds and stock markets to create a seamless equity market for innovation. Finally, inter-regional and transnational links are essential for the efficient exchange of knowledge, people and good practice, and the frictionless diffusion of new technologies, between individual local and regional innovation systems. There are signs that a 'European Innovation Area' is developing around infrastructures put in place by EU actions such as the Regional Innovation and Technology Transfer Strategies and Infrastructures (RITTS) scheme and the Innovation Relay Centre (IRC) network. Much remains to be done, however. Among technology-oriented European firms, the United States remains a more popular location than other EU Member States for research activity and technological collaboration outside their own national borders. In 1990-95, for example, 53.1% of patents resulting from the research activities of European companies outside their home countries originated in the US, compared with only 40.4% in Europe.

These 12 studies demonstrate the crucial role played by innovation in business competitiveness and growth. Innovation is the source of new and improved products, services and processes, and *may* create entirely new markets, opening up new areas of economic and social activity. It is enterprises which must meet the challenges of innovation, and grasp its opportunities. But public authorities play a vital part in creating conditions in which innovation's wider social and economic benefits can be maximised. The insights offered by these studies provide valuable support to public policy-makers' efforts in this increasingly important area.

Note de synthèse

Cette brochure synthétise douze rapports, concluant une première série d'études sur la politique d'innovation réalisées à la demande de la Direction générale Entreprises de la Commission européenne. Neuf de ces rapports ont été commandés dans le but d'examiner les tendances et la portée de la politique européenne en matière d'innovation ou pour éclairer certains aspects spécifiques intéressant les instances politiques. Un certain nombre d'entre elles utilisent l'ensemble unique de données rassemblées par l'Enquête communautaire sur l'innovation relatives aux activités innovantes des entreprises en Europe. Les trois autres évaluent certaines mesures spécifiques qui concernent respectivement le financement de l'innovation, la promotion des techniques de gestion de l'innovation au sein des petites et moyennes entreprises (PME) et le développement de stratégies d'innovation régionales. Toutes ces études sont destinées à mieux comprendre la dynamique de l'innovation européenne, à travers ses mécanismes, ses vertus et ses limites. Elles renforcent donc l'aptitude des responsables politiques régionaux, nationaux et communautaires à développer les capacités novatrices de l'Europe à l'aide d'une législation et de mesures de soutien efficaces, adéquatement ciblées et qui se renforcent mutuellement.

Divers thèmes sont abordés. Les rapports compilés ici découlent d'études séparées, menées par plusieurs équipes de chercheurs indépendantes. Un certain nombre de messages clés émergent pourtant de ce matériel, avec un degré de consistance frappant.

Tout d'abord, **l'innovation est plus importante que jamais** au sein de l'économie actuelle, de plus en plus mondialisée et fondée sur le savoir. La compétitivité repose beaucoup plus largement que par le passé sur l'aptitude des secteurs de l'industrie et des services à satisfaire les besoins extrêmement fluctuants du marché avec célérité et efficacité grâce à l'application de nouvelles technologies. Cette faculté d'assimiler et d'appliquer de nouvelles connaissances en vue d'améliorer la productivité et de créer de nouveaux produits et services repose sur notre inventivité scientifique et sur la perspicacité des entrepreneurs. Mais elle est aussi profondément influencée par les conditions qui permettent, encouragent et soutiennent l'esprit de création et l'investissement ou celles qui les entravent et les limitent.

Au 21e siècle, **l'innovation sera au centre de toute politique d'entreprise et industrielle fructueuse,** mais elle devra également influencer les politiques menées dans des domaines tels que l'éducation, la législation de l'emploi et la taxation.

Ensuite, **l'innovation est diffuse et variée.** Elle est – et doit être – présente dans les entreprises de toutes envergures, dans chaque région et dans tous les secteurs, au-delà des secteurs de pointe considérés comme "naturellement innovants" tels que la biotechnologie ou les technologies de l'information. Ces secteurs émergents sont les moteurs d'innovations essentiels pour toute notre économie et peuvent s'avérer d'importantes sources de futurs emplois, mais ils n'interviennent pour le moment que pour une part relativement faible du PIB de l'Union européenne. En se concentrant exclusivement sur les technologies de pointe, la politique d'innovation risque de passer à côté d'opportunités beaucoup plus importantes en vue d'améliorer la compétitivité des industries plus traditionnelles et de créer de nouveaux produits et procédés dans ce secteur, qui regroupe encore les principaux employeurs de l'Union européenne. Les activités de recherche et de développement ne sont pas la seule source de nouvelles connaissances. Celles-ci proviennent également d'investissements en termes d'installations et de machinerie industrielles et du développement des ressources humaines. Même dans le secteur de l'équipement électrique et électronique de pointe, les dépenses réservées à la recherche et au développement ne représentent que 27% des investissements globalement affectés à l'innovation.

Bien qu'elle soit omniprésente, **l'innovation est distribuée inégalement.** Les performances des Etats membres et de leurs différentes régions varient énormément en termes d'innovation. Plus spécifiquement, les capacités novatrices de l'industrie sont particulièrement concentrées autour des entreprises plus importantes. Il y a en Europe de plus en plus de petites et moyennes entreprises (PME) alertes et dynamiques qui exploitent les technologies. Un certain nombre d'entre elles apportent une contribution vitale au progrès technologique, prospèrent sur les marchés internationaux et croissent rapidement. Mais leur cas ne peut pas masquer le fait que les capacités novatrices de la plupart des PME à vocation technologique restent faibles. Les PME ont tendance à manquer à la fois des ressources internes et des réseaux externes nécessaires pour accéder facilement aux connaissances, aux compétences, aux technologies et au financement dont dépend l'innovation. De plus, les PME axées sur les technologies sont entravées par de nombreux obstacles institutionnels et par des frais disproportionnés – 49% par exemple hésitent à investir dans l'invention, craignant de ne pouvoir assumer, en cas de litige, les frais associés à la défense des brevets.

Quatrièmement, l'innovation est plus systémique que linéaire. C'est-à-dire que les processus d'innovation sont multidimensionnels. Ils impliquent de nombreux partenaires distincts et s'étendent souvent sur de longues périodes. Une innovation fructueuse *peut* occasionner un transfert de technologie – par exemple d'une université ou d'un centre de recherche vers une entreprise – mais c'est rarement un événement isolé. La rapidité et la réussite du transfert dépendent très probablement d'autres interactions, avant et après le transfert lui-même, et elles sont largement soumises aux conditions de "l'environnement d'innovation" local et national. Par conséquent, l'innovation requiert le développement, sur une longue période, de systèmes intimement connectés. Ce sont donc des systèmes d'innovation efficaces qui assurent la libre circulation de l'information au travers des interfaces qui relient les grandes entreprises, les chercheurs, les entrepreneurs, les investisseurs de toutes sortes, les consultants, les agents en brevets et autres intermédiaires et les autorités locales et autres acteurs. De tels systèmes peuvent avoir des composants techniques mais il s'agit avant tout de réseaux qui regroupent des individus. La proximité est une caractéristique importante de la majorité des systèmes d'innovation, et les responsables politiques consacrent opportunément des ressources à des projets de création de groupements autonomes d'innovateurs locaux et régionaux, souvent situés dans des parcs scientifiques centrés autour d'universités ou de grandes multinationales technologiques. Des interconnections "verticales" sont également indispensables – reliant par exemple des investisseurs informels, des banques, des fonds de capitaux à risque et des marchés financiers en vue de créer un système de " capital investissement " de l'innovation complet. Enfin, l'échange efficace des connaissances, des personnes et des bonnes pratiques et la diffusion sans heurts des nouvelles technologies entre les systèmes d'innovation individuels locaux et régionaux nécessitent des liens interrégionaux et internationaux. Certains signes indiquent qu'un "Espace européen d'innovation" est en train de se constituer autour d'infrastructures mises en place par des initiatives de l'Union européenne comme le plan "Infrastructures et stratégies régionales d'innovation et de transfert technologiques" (RITTS) et le réseau des Centres Relais Innovation (CRI). Mais il reste encore beaucoup à faire. Pour les sociétés européennes axées sur les technologies, les Etats-Unis restent un lieu privilégié par rapport aux autres Etats membres de l'Union européenne pour mener des activités de recherche et de collaboration technologique en dehors de leurs propres frontières. Entre 1990 et 1995, par exemple, 53,1% des brevets émanant des activités de recherche de compagnies européennes à l'extérieur de leur pays d'origine ont été déposés aux Etats-Unis, tandis que seulement 40,4% l'ont été en Europe.

Ces douze études démontrent le rôle majeur joué par l'innovation en matière de compétitivité et de croissance économique. L'innovation est source de produits, de services et de procédés nouveaux et améliorés. Elle peut être à l'origine de marchés entièrement neufs, ouvrant de nouveaux secteurs d'activité économique et sociale. Ce sont les entreprises qui doivent relever les défis de l'innovation et en saisir les opportunités. Mais les pouvoirs publics ont un rôle prépondérant à jouer en créant les conditions qui permettent de tirer le meilleur parti des avantages sociaux et économiques de l'innovation. Les éclaircissements apportés par ces études offrent un précieux soutien aux efforts fournis par les pouvoirs publics dans ce domaine d'importance grandissante.

Überblick

Diese Broschüre stellt zwölf Berichte in Kurzform vor. Sie ist die erste in einer neuen Studienreihe zur Innovationspolitik, die im Auftrag der Generaldirektion Unternehmen der Europäischen Kommission erscheint. Neun Berichte untersuchen die Trends und Auswirkungen europäischer Innovationspolitik oder beleuchten spezifische, für politische Entscheidungsträger relevante Aspekte. Viele dieser Berichte greifen auf den einzigartigen Datenbestand über die Innovationstätigkeit auf Unternehmensebene in Europa zurück, der im Rahmen der Innovationserhebung der Gemeinschaft zusammengetragen wurde. Drei der Berichte bewerten spezifische Maßnahmen in den Bereichen Innovationsfinanzierung, Förderung von Techniken des Innovationsmanagements in kleinen und mittleren Unternehmen (KMU) und der Entwicklung regionaler Innovationsstrategien. Alle Berichte haben das gleiche Ziel: ein besseres Verständnis der Dynamik europäischer Innovation, d.h. ihrer Mechanismen, Stärken und Hindernisse. Sie helfen damit den regionalen, nationalen und EU-Politikern ein Instrumentarium wirksamer, zielgerichteter und sich gegenseitig befruchtender Gesetzes- und Fördermaßnahmen zur Stärkung der Innovationsleistung in Europa zu entwickeln.

Die hier angeschnittenen Themenkomplexe sind vielschichtig. Die zusammengefassten Berichte sind zwar das Ergebnis von Untersuchungen einzelner, unabhängiger Forscherteams, doch sie enthalten eine Reihe auffallend übereinstimmender Schlüsselbotschaften.

Erstens: **Innovation ist ein immer wichtigeres Element** in unserer zunehmend globalisierten, wissensbasierten Wirtschaft. Mehr denn je hängt Wettbewerbsfähigkeit heute davon ab, wie es dem Fertigungs- und Dienstleistungssektor mit Hilfe neuer Technologien gelingt, sich rasch und effizient auf die schnellebigen Marktbedürfnisse einzustellen. Diese Fähigkeit, neues Wissen zur Steigerung der Produktivität und für die Schaffung neuer Produkte und Dienstleistungen aufzugreifen und anzuwenden, beruht einerseits auf wissenschaftlichem Erfindungsgeist und andererseits auf unternehmerischem Spürsinn. Sie werden zudem ganz entscheidend beeinflusst von den Bedingungen, die innovative Kreativität und Investitionen anregen und nachhaltig fördern bzw. ihre Entwicklung hemmen und begrenzen. Im 21. Jahrhundert wird Innovation die Hauptantriebskraft für erfolgreiche Industrie- und Unternehmenspolitik sein, und sie muss gleichermaßen auch andere Politikbereiche wie etwa Bildung, Arbeitsgesetzgebung und Steuerwesen betreffen.

Zweitens: **Innovation ist omnipräsent und vielfältig.** Innovation findet in jedem Unternehmen statt bzw. sollte in jedem stattfinden, ungeachtet seiner Größe, der Region und des Sektors; sie beschränkt sich nicht nur auf die „ per se innovativen" High-Tech-Sektoren wie Biotechnologie und Informationstechnologie. Diese aufstrebenden Sektoren sind zwar als Motor wirtschaftsweiter Innovation von entscheidender Bedeutung und können auch zu einem wichtigen Quell künftiger Beschäftigungsmöglichkeiten werden. Heute stellen sie indes noch immer einen relativ geringen Anteil des BIP der Europäischen Union dar. Eine Innovationspolitik, die ausschließlich in Hochtechnologiesektoren greift, läuft daher Gefahr, sehr viel größere Chancen für eine erhöhte Wettbewerbsfähigkeit sowie für neue Produkte und Prozesse in eher traditionellen Industrien, die nach wie vor die Eckpfeiler der Wirtschaft in der Europäischen Union bilden, zu vereiteln. Neues Wissen wird nicht nur durch Forschung und Entwicklung gebildet, sondern ist auch das Ergebnis von Investitionen in Fertigungsanlagen und Maschinen sowie der Entwicklung von Humanressourcen. Selbst im High-Tech-Sektor der Elektro- und Elektronikgeräte betragen die FuE-Ausgaben nur rund 27% der Gesamtinvestitionen in Innovation.

Drittens: **Innovation**, wenngleich omnipräsent, ist **ungleichmäßig verteilt.** Die Innovationsleistung der Mitgliedstaaten und verschiedenen Regionen in den einzelnen EU-Mitgliedsländern stellt sich sehr unterschiedlich dar. Oder konkreter: Die Innovationsleistung der Industrie ist hauptsächlich in größeren Unternehmen konzentriert. Allerdings wächst die Zahl flexibler und dynamischer technologiebasierter kleiner und mittlerer Unternehmen (KMU) in Europa. Viele leisten einen wesentlichen Beitrag zum technologischen Fortschritt, fassen mit großem Erfolg auf internationalen Märkten Fuß und erreichen ein schnelles Wachstum. Doch diese positiven Beispiele können nicht darüber hinwegtäuschen, dass die Innovationsfähigkeit der meisten technologienutzenden KMU nach wie vor schwach ist. Gewöhnlich fehlt es den KMU sowohl an internen Ressourcen wie auch an externen Netzwerken, den unabdingbaren Voraussetzungen für den einfachen Zugang zu Wissen, Fähigkeiten, Technologien und Finanzierungsmöglichkeiten, von denen Innovation abhängt. Darüber hinaus sind technologieorientierte KMU unverhältnismäßig stark von zahlreichen institutionellen Barrieren und Kosten betroffen – für 49% ist die Angst vor Patentprozesskosten ein entscheidender Hinderungsgrund, um beispielsweise in Erfindungen zu investieren.

Viertens: **Innovation ist ein systemischer Prozess,** sie verläuft nicht linear. Innovationsprozesse sind folglich multidimensional: sie können sich unter Mitwirkung ganz unterschiedlicher Akteure über längere Zeiträume erstrecken. Erfolgreiche Innovation kann zwar einen Technologietransfer – etwa von einer Universität oder Forschungseinrichtung zu einem Unternehmen – bewirken, aber dies ist nur in seltenen Fällen ein isolierter Vorgang. Geschwindigkeit und Erfolg eines Technologietransfers hängen fast immer von anderen Interaktionen, vor und nach dem Transfer selbst, ab und sind stark von den Bedingungen des lokalen und nationalen „Innovationsumfelds" beeinflusst. Innovation erfordert daher die Entwicklung eng miteinander verzahnter Systeme über einen längeren Zeitraum. Es sind vor allem gut funktionierende Innovationssysteme, die dafür sorgen, dass der Informationsfluss frei über die Verbindungsstellen zwischen Großunternehmen, Forschern, Unternehmern, Investoren aller Art, Beratern, Patentanwälten und anderen Vermittlern, lokalen Behörden wie auch anderen Akteuren läuft. Solche Systeme mögen zwar technische Komponenten mitbeinhalten, sie zeichnen sich aber vornehmlich durch die Kontakte von Einzelpersonen aus. Nähe ist das Schlüsselwort bei den meisten Innovationssystemen, und Politiker stellen mit gutem Grund Mittel für Projekte bereit, die auf die Schaffung sich selbst tragender lokaler und regionaler innovativer Cluster abzielen, sei es in Technologieparks im Umfeld von Universitäten oder Technologiekonzernen. Auch „vertikale" Verbindungen sind unerlässlich – etwa um Verbindungen zwischen Business Angels, Banken, Risikokapitalfonds und Aktienmärkten im Hinblick auf die Schaffung eines nahtlosen Aktienmarktes für Innovation herzustellen. Schließlich tragen auch interregionale und transnationale Verbindungen entscheidend zum wirksamen Austausch von Wissen, Personen und guter Praxis sowie zur problemlosen Verbreitung neuer Technologien zwischen einzelnen lokalen und regionalen Innovationssystemen bei. Erste Anzeichen weisen auf die Entstehung eines „Europäischen Innovationsraums" um Infrastrukturen hin, die durch EU-Maßnahmen wie die Regionalen Innovations- und Technologietransfer-Strategien und –Infrastrukturen (RITTS) und das Netz der Innovationszentren (Innovation Relay Centre, IRC) geschaffen wurden. Trotzdem bleibt noch vieles zu tun. Als Standort für Forschungstätigkeit und für technologische Zusammenarbeit außerhalb der eigenen Landesgrenzen bevorzugen technologieorientierte europäische Unternehmen nach wie vor nicht andere EU-Mitgliedstaaten, sondern die Vereinigten Staaten. So stammten zwischen 1990 und 1995 53,1% der Patente, die aus Forschungsarbeit europäischer Unternehmen im Ausland hervorgegangen sind, aus den USA, während es für Europa nur 40,4% waren.

Die 12 vorliegenden Studien belegen die tragende Rolle von Innovation für die Wettbewerbsfähigkeit und das Wachstum von Unternehmen. Innovation ist der Quell neuer und verbesserter Produkte, Dienstleistungen und Verfahren. Sie kann gänzlich neue Märkte schaffen und neue wirtschaftliche und gesellschaftliche Tätigkeitsfelder erschließen. Aber es liegt an den Unternehmen, sich den Herausforderungen der Innovation zu stellen und die Chancen zu ergreifen. Doch die öffentliche Behörden spielen einen wesentlichen Part: sie müssen die Bedingungen schaffen, unter denen sich die breiteren gesellschaftlichen und wirtschaftlichen Vorteile von Innovation voll ausschöpfen lassen. Die im Rahmen dieser Studien gewonnenen Einsichten stellen eine wertvolle Hilfe für politische Entscheidungsträger in diesem immer wichtigeren Bereich dar.

Introduction

Understanding Innovation's Levers

In today's increasingly global, increasingly knowledge-based economy, innovation – the capacity to apply new knowledge in order to improve productivity and create new products and services – assumes an unprecedented significance. This capacity relies not only on scientific inventiveness and entrepreneurial flair but, critically, on the conditions which permit, encourage and sustain this innovative creativity, or which restrict it. Effective policy-making depends on authoritative analysis of the multiple institutional and regulatory levers which stimulate or stifle company-level innovation.

To remain competitive, today's companies need to do more than simply deliver products or services that are better or cheaper than those of their rivals. They must also add features, improve performance and reduce prices more quickly. They must be faster to launch new products. If they want to grow, they may have to enter – or even create – new markets. The real stars reinvent themselves not once, but over and over again.

Innovation is now the single most important engine of long-term competitiveness, growth and employment. The OECD estimates that between 1970 and 1995 more than half the total growth in output of the developed world resulted from innovation, and the proportion is increasing as the economy becomes ever more knowledge-intensive.

For the past half-century, and especially during the 1990s, the European Union has failed to match the dynamic, self-sustaining technological innovation which has characterised the United States' economy. But the objective of increasing Europe's innovative capacity, in particular by strengthening networks and improving framework conditions through the removal of fiscal and regulatory disincentives, is now very high on the EU's political agenda.

In March 2000, the European Council in Lisbon emphasised innovation's central role as an engine of growth in employment and competitiveness, and as a cornerstone of enterprise policy. It called for a series of benchmarking exercises as a means of monitoring progress by the EU and Member States towards the implementation of effective policies – and in particular, in support of innovation.

In September 2000, the European Commission responded to this request in its Communication *Innovation in a knowledge-driven economy*(1). This describes, among other objectives, the Commission's intention to contribute to the improved coherence of innovation policy in Europe by:

- examining and benchmarking the innovation policies and performance of Member States, and comparing them with those of their main competitors – the US and Japan
- establishing a European innovation scoreboard
- contributing to regular reports on Europe's competitiveness performance from the perspective of innovation

The Commission plans to develop a framework for dialogue on innovation policy-making and policy co-ordination, to improve the availability of innovation statistics, and to help identify 'best practice' in innovation policy. As part of this overall effort, it will also undertake analysis of key developments around the world and studies on specific innovation-related themes.

Innovation Policy Studies

EU innovation policy is concerned not only with research and development, although it has done much to make possible the rapid diffusion of new scientific knowledge across national and sectoral borders. And although it supports the creation and growth of high-tech start-up firms as the most dynamic components of regional innovation systems, it spans traditional as well as emerging sectors, and addresses investors and educationalists as well as entrepreneurs.

The interactions between the components of an innovation system, and the elements of the regulatory framework in which it operates, are highly complex. Effective EU, Member State and regional innovation policy depends on real understanding of what drives innovation at company level, the external barriers which prevent or delay it, and its impacts on competitiveness and employment.

This brochure reviews and summarises the first 12 reports in a series of Innovation Policy Studies commissioned by the Innovation Directorate of the European Commission's Directorate-General for Enterprise as part of the Innovation and SMEs programme of the EU's Fifth Research Framework Programme. Many make detailed use of the dataset – unique in the world – assembled by the Community

(1) COM(2000) 567 final. The full text can be downloaded from http://www.cordis.lu/innovation-smes/communication2000/home.html

Innovation Survey, which gathers comparable data about firm-level innovation activity across the EU in a joint action of the Enterprise DG and Eurostat, the EU statistical office. Following a 1992 pilot project (CIS1), the second survey (CIS2) was conducted in 1997-98, and examined both manufacturing and service sectors. These studies, carried out by the Innovation Directorate with the assistance of external technical experts, are designed to enhance Europe's capacity to understand and improve its innovative performance. Addressing innovation policy issues identified by the Commission as priorities in relation to company-level innovation and its framework conditions, they give Europe's political, industrial and institutional decision-makers access to international experience, to the results of authoritative and up-to-date research, and to assessments of existing policy instruments. Taken as a whole, the study series will help them to develop reliable and meaningful benchmarks, to identify, share and adapt best practice, and to introduce practical and mutually reinforcing support measures with maximum efficiency.

This brochure

The 12 study summaries contained in this brochure are grouped together by topic in five chapters which address, respectively:

1. broad national and EU innovation policy
2. technology transfer – the conversion of research results into commercial products and services
3. the financing of innovation – in particular, by banks and venture capital funds
4. innovation management within firms, and especially within small and medium-sized enterprises
5. regional issues and approaches

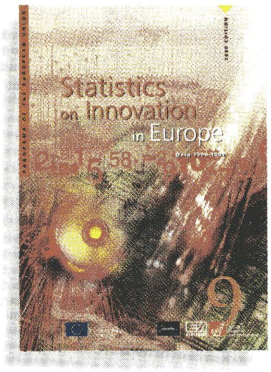
Although it is hoped that each summary will serve to reinforce and elucidate those around it, no attempt has been made to impose overall consistency not present in the reports themselves. Instead, the summaries outline the most significant findings and recommendations of each study. Full publication details (including, where relevant, the price) are also given for each report. Finally, a table of references (pages 64-65) identifies passages in each of the 12 reports which treat 20 priority topics such as innovation financing and university-industry interfaces, while details of future Innovation Policy Studies either in progress or planned are set out in 'Forthcoming Studies' (pages 66-67).

chapter I **Innovation Policy**

The regular collection and analysis of information about innovation behaviour by individual firms, and about measures implemented by Member States to assist innovative enterprises, constitutes a vital input to regional, national and EU policy-making. It provides a platform for the assessment of actual innovation performance, and for the efficient development of policies to stimulate and support innovation as a key source of future competitiveness, employment and economic growth in Europe.

1.1

Statistics on Innovation in Europe, 2000 edition



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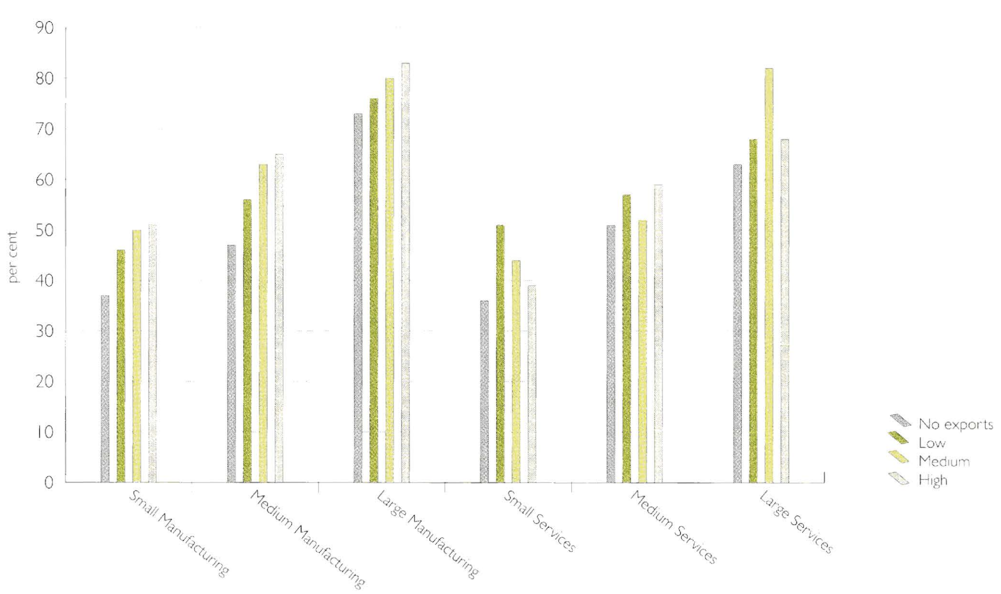
Key Findings

- Over half of all European manufacturing enterprises (51%) and 40% of those in the service sector are **technological innovators**, but these proportions vary widely between countries.
- The larger the firm, the more likely it is to be an innovator. Among all manufacturing firms, **large firms** spend nearly twice as large a proportion of their turnover (4.2%) on innovation activities as do small ones (2.5%).
- **SMEs** account for 29% of Europe's total manufacturing sales, but for only 18% of sales of innovative products.
- Even in the **low-tech sectors** 36% of small, 49% of medium and 71% of large firms are innovators.
- The acquisition of **machinery and equipment** is a source of product or process innovation for 60% of small innovators, and for 69% of medium-sized ones.
- **Universities** and public research institutes are considered to be key sources of innovation information by less than 5% of innovating firms, and **patents** by only 3% of manufacturing innovators and 1% of those in the service sector.
- Among **collaborating innovators**, 84% of manufacturers and 74% of service sector firms work with domestic partners, while 50% of manufacturers and 37% of service sector firms work with partners in other EU countries.

Number of innovators by export intensity, breakdown by size class, EEA, 1996

Source: CIS2, Eurostat/Enterprise DG

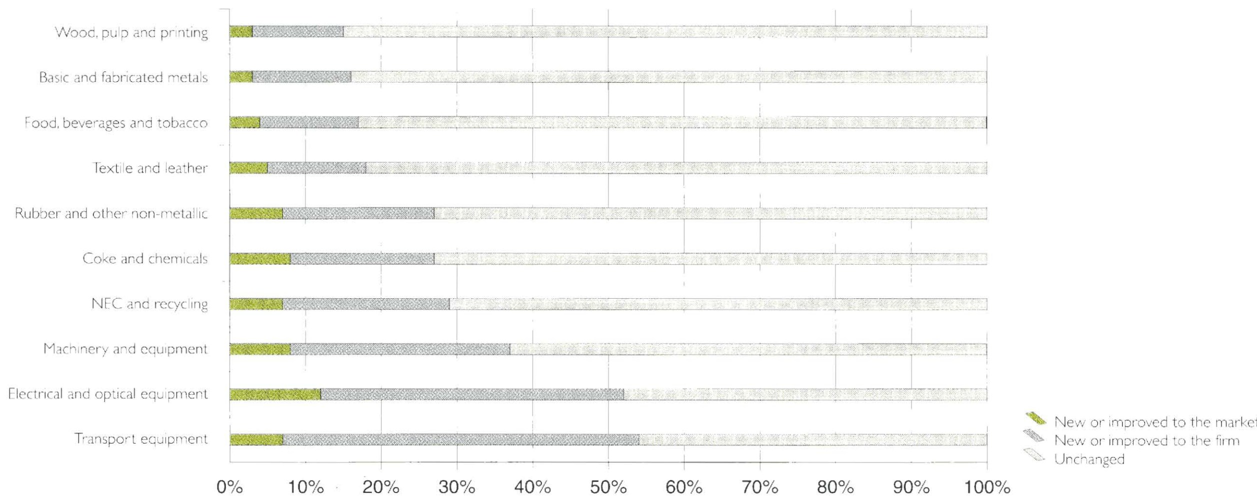
Figure 1.1



Sales new to market, new to firm and unchanged, all manufacturers, 1996

Source: CIS2, Eurostat/Enterprise DG

Figure 1.2



The challenges and opportunities presented by globalisation and the new knowledge-driven economy require a radical transformation of enterprise policies in the European Union. The EU's robust current economic and employment growth coexist with persistent structural unemployment and a widening skills gap, especially in emerging high-tech fields.

The strategic goal set at the European Council Summit in Lisbon in March 2000, "to make the European Union the most competitive and dynamic knowledge-based economy in the world" by the end of the decade, necessitates new policy initiatives – at EU, national and regional levels – to make Europe more entrepreneurial and more innovative.

The Community Innovation Survey (CIS) is undertaken jointly by the European Commission and the statistical offices of the European Economic Area's Member States (EEA). It assembles information on technological innovation in Europe, as a contribution to the development of effective policies supporting innovation and the spread of new technologies. Using a common methodology, CIS gathers internationally comparable data on the resources devoted to innovation at firm level, as well as its impacts on competitiveness.

Statistics on Innovation in Europe presents an overview of the results of the second CIS (1997-98), by country and firm size, and makes a detailed comparison between high-tech industries and other manufacturing sectors. For the purposes of the CIS, innovative firms ('innovators') are those which have introduced a technologically new product, process or service during the previous three years. The survey covers not only R&D inputs but also the acquisition of machinery, software or other technology, as well as training and market introduction. In respect of product innovations, it distinguishes between those which are simply new to the firm itself and those which are also new to its market ('novel').

How much innovation?

Over half of all European manufacturing enterprises (51%) are technological innovators, but this proportion varies widely between countries – from around 70% in Ireland, Denmark and Germany to around 30% in Belgium, Spain and Portugal. In almost every Member State, there are fewer innovators in the service sector than in manufacturing industry – just 40% across the EU as a whole.

Among manufacturing innovators, 12% reported only process innovations and 24% only product innovations, while 64% had implemented both product and process innovations. Process innovation is more likely to rely on technologies developed outside the firm. Only 48% of process innovations were carried out on the basis of in-house R&D, compared with 73% of product innovations. Just 8% of product innovators and 28% of process innovators relied exclusively on externally developed technologies.

Among product innovators, which represent 44% of all EU manufacturing enterprises, slightly less than half were 'novel innovators' – that is, having introduced products not simply new to the firm but new to its market. Italy and France, both with a relatively small proportion of product innovators, nevertheless have a high share of novel innovators. In Germany and the United Kingdom, by contrast, the overall share of product innovators is high, while the proportion of novel innovators is low.

Overall, the larger the firm, the more likely it is to be an innovator (Figure 1.1). On average across the EU, innovations were introduced by 79% of large manufacturing firms (those with more than 250 employees), by 58% of medium-sized ones (50-249 employees) and by just 44% of small ones (fewer than 50 employees). In the service sector, the corresponding figures were 73% for large, 49% for medium and 37% for small firms.

By industrial sector, the average proportion of innovators across the EU ranges from close to 70% in the coke and chemicals, electrical and optical equipment, and machinery and equipment industries, to just 35% in the textile and leather industry. There is little variation in the sectoral distribution of innovators between countries.

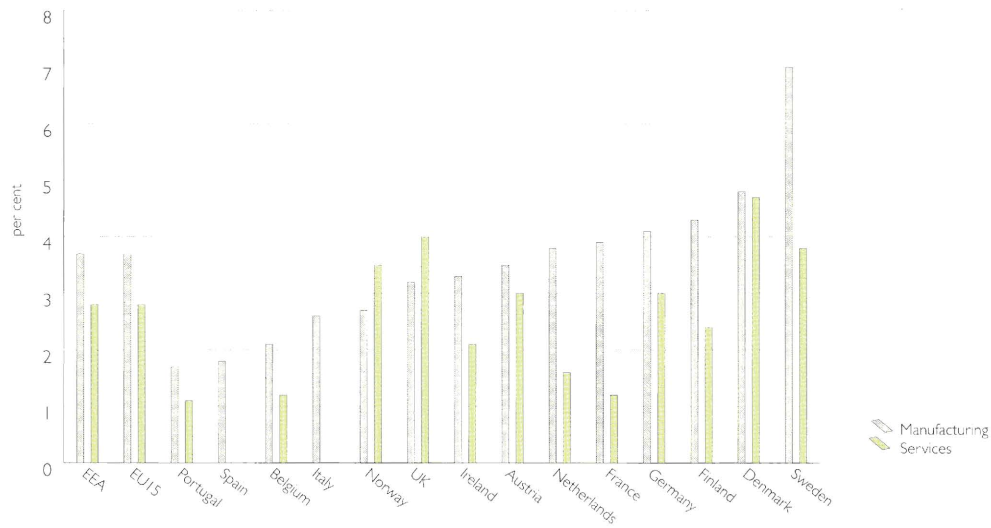
When manufacturing industry as a whole is divided according to level of technology – with the aerospace, computer, office machinery, electronics, communications and pharmaceuticals industries classified as high tech – a slightly different picture emerges. Unsurprisingly, innovators form a large

Innovation intensity (share of total turnover spent on innovation), all enterprises*, 1996

Source: CIS2, Eurostat/Enterprise DG

* Service sector data not available for Spain and Italy

Figure 1.3



majority (71%) of high-tech sector firms, but a minority (43%) of those in the low-tech sectors. Even in the low-tech sectors, however, 36% of small, 49% of medium and 71% of large firms are innovators. Whatever the level of technology, large firms include a considerably higher proportion of innovators than medium-sized and small ones.

The high-tech sectors account for only 3% of all European manufacturing firms, and generate only 9% of total manufacturing sales. But the high and medium-high tech sectors together contribute a disproportionately large share of sales of new and improved products – 70% and 71% respectively. The medium-high tech sectors in particular (scientific instruments, motor vehicles, electrical machinery, chemicals, other transport equipment and non-electrical machinery) can be characterised as the engines of product innovation in Europe, contributing 56% of new and 63% of improved products.

The impacts of innovation

Innovative (recently introduced or improved) products account for fully one-third of all European manufacturing sales – but this means that the great majority of Europe's industrial turnover derives from products which have remained unchanged for at least three years.

Sales of innovative products as a proportion of total turnover increase with firm size – from 15% for small firms to 21% for medium-sized and 38% for large ones. Small and medium-sized enterprises account for 29% of Europe's total manufacturing sales, but for only 18% of sales of innovative products.

In general, in countries with a large proportion of innovating companies, new or improved products also represent a comparatively large share of total manufacturing sales. But in Spain, with only 29% of innovators among its manufacturing firms, new or improved products generate around 28% of manufacturing turnover, close to the EU average of 32%, outperforming Denmark, where 71% of all manufacturers are innovators.

Among innovators alone, sales of new or improved products represent over 40% of turnover. Significantly, this share varies remarkably little with firm size – while small innovating firms devote proportionately more resources to innovation (see below), larger ones may benefit from economies of scale.

The share of total turnover generated by new or improved products varies widely between manufacturing sectors (Figure 1.2). In the transport equipment and electrical and optical equipment sectors they account for over 50% of sales, but in the wood, pulp and printing and basic and fabricated metals sectors only 15%. Novel products, new to the market, represent by some margin the highest proportion of total sales (12%) in the electrical and optical equipment sector.

Patents are a traditional indicator of innovation activity. In the three previous years, 25% of innovating manufacturers and 7% of service sector innovators applied for at least one patent. Among manufacturers, patent applications increase markedly with firm size – only 15% of small innovators applied for a patent, compared with 28% of medium-sized and 51% of large ones. Use of the patent system also varies widely by country. In Finland, 40% of innovative firms applied for a patent, compared with only 11% of Portuguese innovators.

Expenditure on innovation

Innovation among enterprises encompasses not only the creation of knowledge through research and technological development but also the various processes by which new technology is diffused, absorbed and applied. Innovation may involve investment in capital equipment or intermediate goods which embody new technologies, as well as in the development of intangible assets of knowledge and skill. In both cases, such activity may be carried out in-house or may involve the acquisition of equipment, goods, services or know-how from outside the firm. The CIS collects information about firms' expenditure on all these aspects, allowing comparative analysis of investment in innovation using the ratio of expenditure on innovation activities to total company turnover – called 'innovation intensity'.

Across the EU, innovation intensity is 3.7% in manufacturing sectors, and 2.8% in service sectors (Figure 1.3). In manufacturing sectors, Portugal, Spain and Belgium, which have the smallest proportion of innovating firms, also have the lowest innovation intensity – 2% or less. At the other end of the spectrum, however, the innovation intensity of Sweden's manufacturing sectors is as high as 7%, despite the relatively low proportion of innovating firms. In Sweden, therefore, innovation is tightly concentrated in a small number of highly innovation-intensive firms. Ireland's innovation intensity, by contrast, is below the EU average, although it has the highest proportion of innovating firms (74%) of any Member State.

On average, among all manufacturing firms, large companies spend nearly twice as large a proportion of their turnover (4.2%) on innovation activities as do small ones (2.5%). This difference is especially pronounced in Sweden, Finland and France, while in Denmark and Austria, small firms spend on average a higher proportion of turnover on innovation than do medium-sized and large ones. Among innovating firms, across the EU as a whole small companies' innovation intensity (5.1%) is higher than that of large ones (4.7%). This is true both in manufacturing and service sectors – strong evidence that innovating SMEs play as large a part in European innovation as large innovators.

Innovation intensity varies from over 10% in the high-tech sectors to less than 2% in the low-tech ones. In the high-tech

market analysis, staff training and a range of other factors are also likely to be involved.

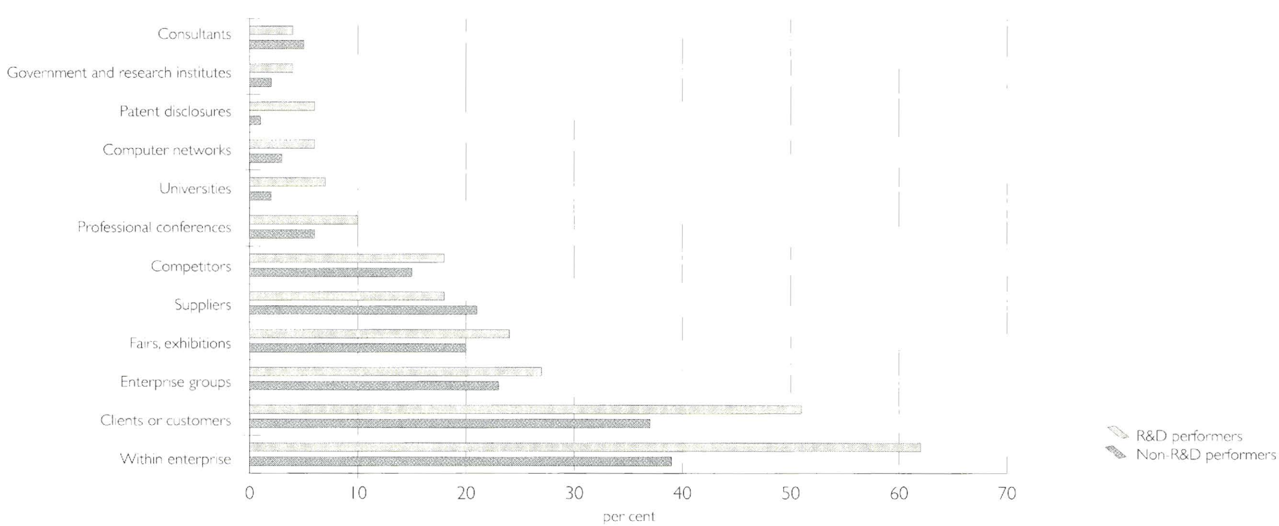
In European manufacturing industry, around 80% of innovative firms make use of R&D – 58% employing in-house resources. But the acquisition of technology embodied in machinery purchased from third-party suppliers is also a source of innovation for over 65%. Innovation activities other than R&D are especially important for medium-sized and small enterprises – while over 80% of innovating large firms engage in in-house R&D, this is a feature of the innovation process for only 45% of small innovators. The acquisition of machinery and equipment is a source of product or process innovation for 60% of small innovators, and for 69% of medium-sized ones.

In the service sector, research and development is an element of the innovation process for only 55% of innovators, and only 40% rely on in-house R&D. Here, the acquisition of machinery and disembodied technology in the form of know-how, licences, trademarks and consultancy services constitutes the most significant innovation input, while training and other investment in intangible assets are also proportionately more important than they are for manufacturing industry.

Share of manufacturers valuing sources of information for innovation, EEA, 1996

Source: CIS2, Eurostat/Enterprise DG

Figure 1.4



sectors, innovation intensity ranges by firm size from 10.7% among large firms to 7.7% for small ones and just 5.7% for medium-sized ones. Among innovators alone, innovation intensity is naturally higher, but especially among smaller firms which, in the low and medium low-tech sectors devote 4.8% of turnover to expenditure on innovation, compared with 2.6% for large companies. In the high-tech sectors, small firms spend around 11% of turnover on innovation activities, compared with 7% among medium-sized firms and 12% among large ones.

Innovation activities

A firm's capacity to carry technological innovation through to commercial success depends, as already stated, on far more than investment in research and development. Design,

The size of expenditures on different types of innovation activity does not necessarily reflect their relative importance. Training, for example, accounts for less than 2% of innovation expenditure in manufacturing sectors, and around 3% in the service sector, but is likely to have a disproportionate significance as an integrated element of a successful innovation process. Overall, R&D (internal and external) absorbs over 60% of innovation expenditure in manufacturing and over 50% in services. The acquisition of machinery and other, disembodied technology represents 25% of total innovation expenditure in manufacturing and 30% in services.

R&D does not dominate innovation expenditure in all countries, however. In-house R&D accounts for over 60% of the total in manufacturing industries in France and Germany, but only around 30% in Italy and the United Kingdom, and less than 10% in Portugal. The purchase of embodied technology represents over 40% of innovation expenditure in Portugal, Italy, Denmark, Ireland and the UK. Similarly, expenditure on R&D is heavily skewed towards high-tech and medium-high tech sectors. Manufacturers in low- and medium-low tech sectors spend a disproportionate amount on the purchase of machinery and equipment, and on other intangibles (licences, know-how, training, and so on), while expenditure on external (contracted-out) R&D among those in medium-low tech sectors is also relatively high.

Innovation information

Far from being the result of a linear flow of new knowledge from the laboratory to the market place, innovation is systemic – it depends upon complex interactions between many stakeholders. Access to relevant information is therefore a critical element of any successful innovation system, whether at local, regional, national or European level.

The CIS identifies four main sources of information essential to the design and implementation of innovation projects – sources within the enterprise itself (or its group of enterprises), market information acquired from customers, competitors, suppliers or consultants, publicly available information from trade fairs and exhibitions, journals and computer-based networks, and patent databases, and information supplied by universities and research institutes.

In both manufacturing and service sectors, internal sources (around 50%) and clients or customers (around 40%) are the most common suppliers of innovation-related information (Figure 1.4). Notably, universities and public research institutes are considered to be key sources of information by less than 5% of innovating firms, and patents by only 3% of manufacturing innovators and 1% of those in the service sector. As might be expected, high-tech manufacturers make greatest use of conferences and patent disclosures, while 12% use universities and public research bodies as key sources of information.

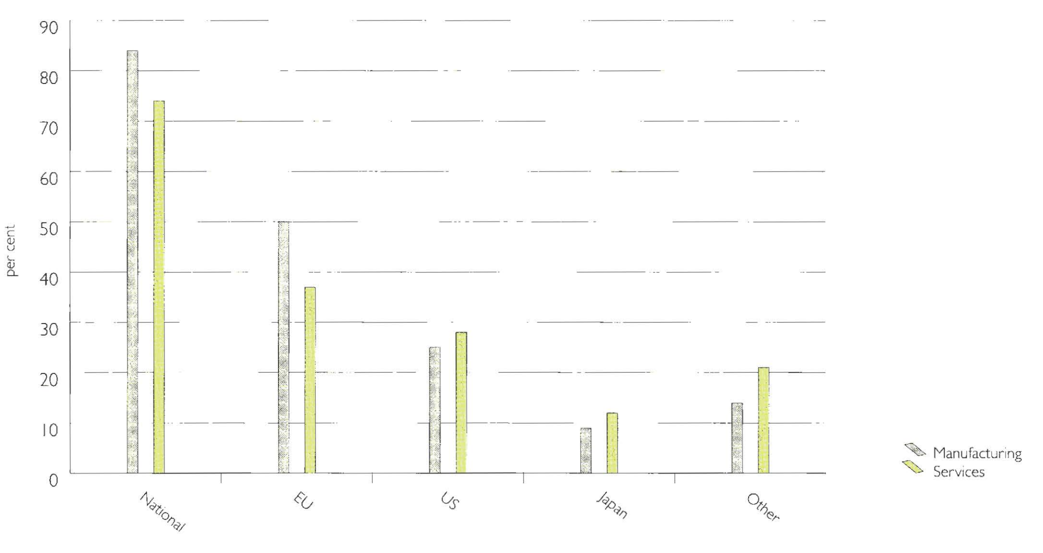
An even greater proportion of large firms than of small ones relies on internal information sources. In both manufacturing and service sectors, 60% of large innovators consider internal sources to be critical, while only 51% of small innovators in the service sector and 43% in manufacturing do so. Small and medium-sized innovators in both manufacturing and service sectors rely to a much greater extent than large ones on trade fairs and exhibitions for innovation-related information.

Trade events are key sources of information for more small innovating manufacturers than any other external information source other than their customers. In every Member State, more innovators rely on trade events than use universities, public research institutes, computer-based networks, professional conferences, consultants or patent disclosures. In Spain, Italy, Austria and Portugal, trade events rank as the third most important source of information for innovating manufacturers, and across the EU as the fourth most important. They are slightly less important in the service sector, where innovators make greater use of computer networks, professional conferences and consultants.

Share of European collaborative innovators by partner location, EEA, 1996

Source: CIS2, Eurostat/Enterprise DG

Figure 1.5



Among manufacturing innovators, around 64% of firms which carry out in-house R&D consider internal information sources critical, compared with just 40% of those with no in-house research capacity. The same group is also more likely to make use of information from their customers.

Innovation networks

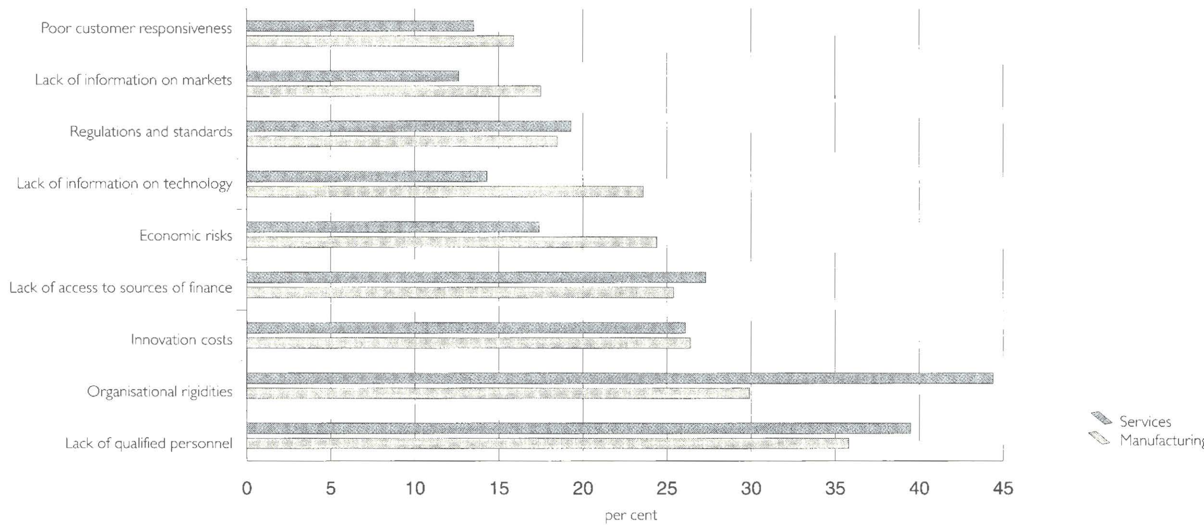
Commercial relationships – with customers and suppliers, and to a lesser extent with competitors – clearly constitute the dominant form of interaction between firms. However, 'non-market interactions' are increasingly common, and increasingly important, especially among innovating firms. For these firms, collaboration can help to lower the costs and risks of innovation, as well as to extract value from new scientific and technical knowledge.

Such interactions include formal and informal collaborative arrangements. Innovation networks or 'clusters' usually involve both horizontal and vertical inter-firm collaboration – both between companies operating in the same industry and

Factors causing innovation projects to be seriously delayed, EEA, 1996

Source: CIS2, Eurostat/Enterprise DG

Figure 1.6



between suppliers and customers along supply chains.

On average, around a quarter of European innovative firms were involved in collaborative arrangements – 27% in the manufacturing and 24% in the service sectors. In the high-tech manufacturing sectors as many as 44% of innovators were involved in collaboration, and in the medium-high tech, 32%. Among innovating manufacturers, partnership was most commonly with other enterprises within the same company group (59%), followed by suppliers (49%), customers (48%), universities (38%) and public research institutes (33%). In the service sector, 68% of innovating collaborators worked with other enterprises in the same group, and collaborations with competitors were more than twice as common as those among manufacturers.

Innovation collaboration is especially common in the Scandinavian countries. Nearly 60% of Swedish and Danish innovating manufacturers, and fully 70% of Finnish ones, had a collaborative arrangement. In southern Europe, by contrast, only around 20% of Spanish and Portuguese innovators collaborate, and only 10% of Italian ones. In most countries, more innovators in the manufacturing sectors engage in collaboration as part of the innovation process than in the service sector. But in Denmark, Belgium and Portugal, a larger proportion of service sector innovators collaborate.

Both in manufacturing and in services, the rate of collaboration among innovating firms increases with size. While around 20% of small innovators have collaborative arrangements, approximately 50% of large ones in the manufacturing sectors do so, and around 35% in the service sector.

Collaboration still occurs mainly between partners in the same country (Figure 1.5). Among collaborating innovators, 84% of manufacturers and 74% of service sector firms work with domestic partners, while 50% of manufacturers and 37% of service sector firms work with partners in other EU countries. Outside the EU, the United States is the most common location for innovation partners – 25% of innovating collaborators in manufacturing, and 28% of those in the service sector, have partners in the US.

Among firms of all sizes, collaboration is correlated with innovations new to the market. While only 36% of manufacturing innovators not involved in collaboration had introduced novel products in the previous three years, 50% of those with innovation partnerships had done so. Similarly, while only 28% of all manufacturing innovators are involved in a collaborative agreement, these account for 50% of the turnover attributable to new or improved products. In Finland, Sweden, Norway, Denmark and France, collaborators generate over 75% of the turnover from innovative products, but in Germany only 37%.

Barriers to innovation

Not all innovation projects are successfully completed – some are aborted or seriously delayed, and others are never started. Financial factors, such as perception of market risk or inability to secure appropriate finance, are not the only barriers, however. Lack of information or skills, regulatory constraints and organisational rigidities within the firm itself may also impede or prevent innovation.

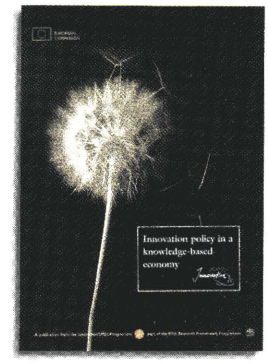
Serious delays had affected at least one innovation project of 27% of innovators in the manufacturing and 37% in the service sectors in the previous three years, while 16% and 15% respectively had abandoned at least one project entirely.

Where projects were seriously delayed, internal factors – in particular, lack of qualified personnel and organisational rigidities – were the commonest cause, and especially so in the service sector (Figure 1.6). Where projects were abandoned or not even started, on the other hand, financial barriers were most often to blame.

Financial barriers, and in particular the costs of innovation and the difficulty of identifying appropriate sources of finance, affect small firms disproportionately, contributing to serious delays and decisions not to start an innovation project for a significantly larger proportion of small innovators than large ones in both manufacturing and service sectors.

1.2

Innovation policy in a knowledge-based economy



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(see back cover) or downloadable from
http://www.cordis.lu/innovation-smes/src/studies.htm

Study team led by:
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Key Findings

- The **knowledge-based** industrial and service sectors are increasing their share of overall economies, while the resources devoted to the production of knowledge are also increasing.
- The efficiency of **innovation systems** is a key determinant of national and regional competitiveness in the global, knowledge-driven economy.
- Innovation and knowledge generation take place as a result of a variety of activities, many of them outside the **formal research** process.
- All firms must integrate more **different types of knowledge** today than in the past. They must also learn to integrate people in a new way, as carriers of **tacit knowledge**.
- Greater **dynamism** and greater willingness to take **risks** with respect to innovation are required. European venture capital funds are still less willing to invest in firms without a proven track record than their US counterparts.
- When European firms locate their **R&D in foreign countries**, they would rather do so in the US than in another EU country.
- While 34% of large R&D-performing firms use **patent disclosure** as an information input to their innovation activities, only 18% of those with fewer than 500 employees do so.

Since the publication of the European Commission's 1996 *First Action Plan for Innovation in Europe*[(1)], the European Union has adopted a system-based approach to innovation policy. In this conceptual framework, technical change and innovation are understood to take place within local, regional, national and European systems which are both dynamic and complex, involving many different processes and many different actors and institutions.

The ultimate goal of innovation policy is to support an increase in the productivity, profitability and market share of European firms through the development and adoption of new or improved products, processes and services. However, measures designed to raise the quantity and efficiency of innovative activities should not focus exclusively on the production and exploitation of new technologies, but must take account of the highly interdependent links between all the many 'innovation actors'. These include not only universities, research centres and industrial firms, but also investors, technology transfer professionals, national and regional policy-makers, patent attorneys and consultants, trade associations and chambers of commerce, and others.

The vitality and effectiveness of innovation systems has always depended on the efficient flow of information between these players. In today's global knowledge-based

(1) COM(96) 589 final, see Bulletin of the European Union, Supplement 3/97, 1997.

economy innovation systems are, increasingly, the critical components of both industrial competitiveness and regional prosperity.

Innovation policy in a knowledge-based economy draws on recent academic insights into the nature of knowledge and innovation systems, and their role in modern economies. It considers empirical evidence – in particular, concerning the form and impacts of the progressive globalisation of technology markets, innovation patterns in the rapidly growing service sector, and the role of intellectual property rights as a mechanism for the dissemination of new knowledge. Finally, it identifies policy priorities for the European Union, based on the foregoing analysis.

Knowledge in the driving seat

In all human societies, economic activity of whatever kind has been based on knowledge. There is general consensus that its role in today's developed economies is qualitatively different – but neither the precise nature of this difference, nor its implications, are yet clear. However, it seems certain that the dynamics of advanced economies increasingly depend less on investments in physical capital, and more on investments in learning and the creation of knowledge.

Today, knowledge is increasingly treated as a commodity, which is packaged, bought and sold in ways and to an extent never seen before – most obviously, in the form of licences to exploit intellectual property. Information and communications technologies (ICTs) play a central role. They reduce the costs and increase the speed of transporting knowledge in the form of data, information and ideas, as well as greatly enhancing our ability to exploit it. The growth of those industrial sectors which produce ICTs' various components, driven by rapidly increasing investment in hardware, software and telecommunications equipment in every sector, has also been a major contributor to recent economic expansion. Yet the development of a knowledge-driven economy is not synonymous with, nor is it encompassed by, the development of ICTs. ICTs are not themselves knowledge, and do not necessarily create or extend knowledge. They are, rather, a resource – albeit one whose growing use accelerates and is in turn accelerated by economic dependence on knowledge.

If knowledge has always been the basis of economic activity, and if the decline in the cost of communication brought about by ICTs merely continues a long historical trend, what is now different is the rate of technological change, and the extent to which knowledge lies at the heart of economic growth. Both are of a different order of magnitude from anything seen in the past.

These trends are mutually reinforcing. In OECD countries, the knowledge-based industrial and service sectors are growing faster than GDP, and thus increasing their share of overall economies. Meanwhile, the resources devoted to the production of knowledge – expenditures on research and development, software, and education and training – are also increasing, as are both the quality and the importance of human resources. According to the OECD's 1999 *Science, Technology and Industry Scoreboard*, in the United States, investment in intangibles and knowledge grew by 3.1% as a share of GDP in the decade 1985-95, and now amounts to 40% of that devoted to fixed capital formation. In this respect, Europe lags behind the US, but only slightly – in the same period, European Union investment in intangibles and knowledge grew by 2.9% as a share of GDP.

Knowledge and innovation

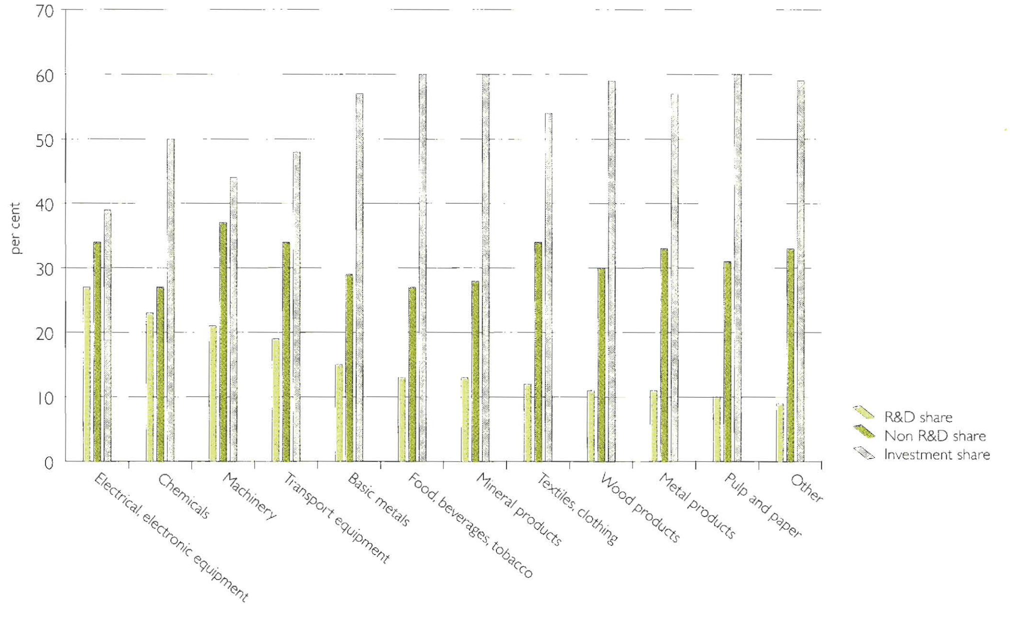
The increasing importance of knowledge as an economic driver has major implications for innovation systems – whose efficiency is, in turn, a key determinant of national and regional competitiveness in the global, knowledge-driven economy.

The systems approach to innovation recognises that innovation and knowledge generation take place as a result of a variety of activities, many of them outside the formal research process. A successful innovation system must be able to take advantage of such 'learning without formal research', for example in the service sector where formal R&D plays a very much less significant role than in manufacturing sectors. In the EU, investment in R&D ranges from 25% of total innovation expenditures in the electrical and electronic equipment sector to just 10% in the pulp and paper sector. The balance is devoted to investment in plant and equipment, software, training, design and market introduction (Figure 1.7).

Composition of innovation expenditures by industry (share of total innovation expenditures)

Source: Community Innovation Survey 1992

Figure 1.7



Knowledge is thus generated not just in universities and research centres, but in a very wide variety of locations within the economy, and notably as a by-product of production (learning by doing) or of consumption (learning by using).

More generally, an innovation system's performance is determined by the rate and efficiency with which new knowledge is diffused throughout the entire system, so that its full economic impact can be realised. In part as a result of the adoption of ICTs, the degree of connectivity among knowledge agents – individuals, institutions and firms – has dramatically increased. The falling cost of connectivity has made possible an increase in the density of the connections within an innovation system, changing its diffusion properties by expanding the number of knowledge sources, and the number of knowledge clients, accessible to each actor.

The importance and difficulty of the task of knowledge management faced by individual companies has increased correspondingly. In all sectors, the knowledge base is becoming broader and more complex at the same time as the speed with which it changes is also increasing. In innovative industries in particular, companies are looking beyond their 'traditional' knowledge bases in their search for new ways to improve products and processes. Innovation consists predominantly of the recombination of existing ideas or knowledge, assembled in a novel way. Today, all firms must integrate more different types of knowledge than in the past. Even industries which perform little or no formal research and development, such as the Norwegian offshore and food-processing sectors, are frequently major users of knowledge generated elsewhere.

In addition, firms must learn to integrate people in a new way, as carriers of tacit knowledge – that is, knowledge not recorded or codified as reusable information. For while our ability to codify and transmit knowledge grows, and the costs of doing so fall, as the result of the ICT revolution, our capacity to exploit it successfully depends on even more rapidly advancing tacit knowledge. The mobility of knowledge is critical, but fast staff turnover resulting from shortages of qualified staff is an extremely inefficient way to achieve such mobility. Joint research or training, secondment and, more generally, trans-sectoral and trans-disciplinary collaboration are likely to offer less costly routes to the effective diffusion of tacit knowledge.

It should be noted that while the new ICTs have facilitated the diffusion of codified knowledge, irrespective of geographical distance, they have not yet done so for tacit knowledge, which must be communicated face to face. Direct interactions remain crucial, and geographical clustering can raise the efficiency of innovation, especially in industries built around new, rapidly developing technologies. Clusters, whether of high-tech firms in and around the science parks of academic centres of excellence, or of supply chains around major manufacturers, tend to become self-sustaining by creating an 'innovation culture' which attracts new players who both benefit from and contribute to it.

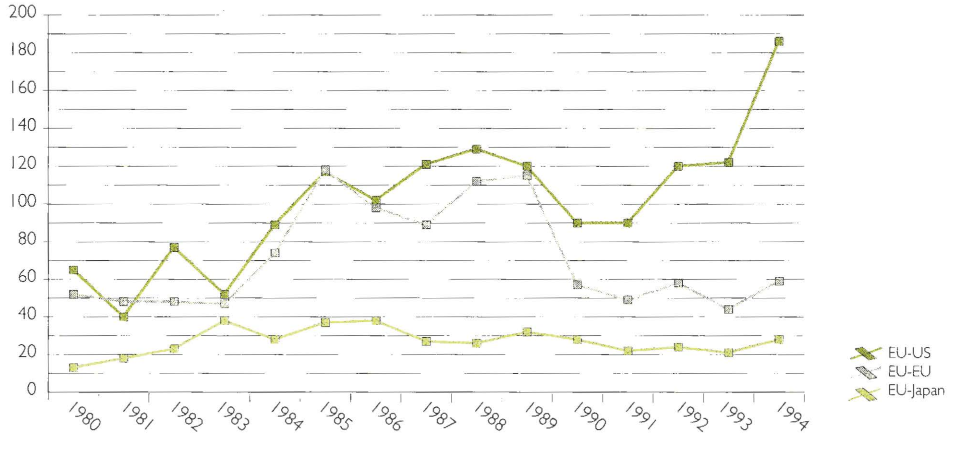
Diffusion and absorption

An effective process of knowledge diffusion needs to be matched by adequate 'absorptive capacity'. The availability of information is not enough. It only becomes useful where the ability to absorb and integrate it exists. For firms, this means maintaining their human capital – through hiring, training and participation in research activities – at a level where staff are able to observe, evaluate and integrate new knowledge developed elsewhere.

At the level of regions and countries, both research and development and education and training are key factors. R&D is important not only as a producer of 'hard' innovations, but as a producer of skills. Public education systems, meanwhile, are the major suppliers of the qualified personnel required by industry. They must be sufficiently specialised to meet industry's human capital needs, but over-specialisation is also a real danger. Diversity and heterogeneity in the knowledge base are often vital in allowing potential innovators to move beyond the product development trajectories which they have inherited from the past, and to develop novel products or to add entirely new features to existing ones. To produce graduates capable of renewing a region's industrial base by absorbing knowledge from outside its established domains, and to enable it to ride out major shifts

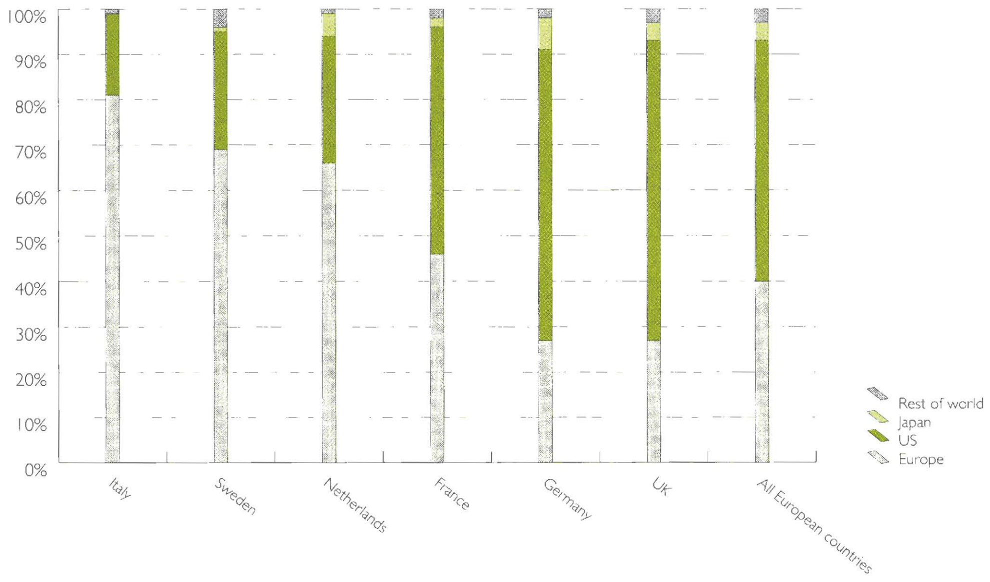
New strategic technological partnerships by EU firms, by location of partner, 1980-94

Figure 1.8



Non-domestic patenting activity of European firms, by host region, 1991-95

Figure 1.9



in the markets it addresses, a regional education system must be broader than the innovating industries it serves.

Not only are many of the costs of acquiring and exploiting new knowledge falling, and the potential benefits of doing so increasing, for any individual innovator. The same is also true for each of his competitors. The cost of *failure* to innovate – in terms of rapid and catastrophic loss of competitiveness – has therefore vastly increased. The knowledge-driven economy calls for greater dynamism and greater willingness to take risks with respect to innovation, and in particular requires a greater emphasis on the role of small and medium-sized enterprises (SMEs).

Young, knowledge-based firms are not only more numerous than in the past, especially in high-tech industries such as biotechnology, software and advanced chemicals, but also play an increasingly important role as innovation agents, as large industrial concerns outsource to smaller specialists a growing share of their research and development activities. However, the assets of start-up companies of this kind are, at least in the early stages, largely intangible – often, they consist of little more than the knowledge and skills of the founders and a few key employees. The impossibility of assessing the market value of such intangibles using conventional methods, even in more mature knowledge-based companies, underlies the volatility of publicly-quoted high-tech stocks. Among early-stage innovative start-ups, it constitutes a real barrier to the rapid growth of which many are capable, since uncertainty in the valuation of a business idea is a powerful deterrent to a risk-averse investor.

As a percentage of GDP, venture capital in Europe remains roughly half that in the US. Further, while 'early stage' capital accounts for fully 40% of all US venture capital, in Europe it is only around 15%. Although the overall availability of venture capital has grown rapidly in the EU since 1995, European funds still appear less willing to invest in firms without a proven track record – or are less skilled at assessing and managing the risks involved in doing so.

Innovation and globalisation

The globalisation of technology is taking place primarily along three routes – first, the international exploitation of nationally produced technology; second, the global generation of innovations by multinational enterprises; and third, global technological collaborations.

An estimated 89% of the total R&D expenditures of the world's largest companies is spent in their home countries, and smaller firms tend to be even less internationalised, concentrating high value-adding activities such as research at home. In 1995, the most technologically intensive sectors accounted for around 20% of all world trade, having more than doubled in the 25 years since 1970. In the same period, however, Europe's share of total world exports in these 'science-based' sectors fell from 48.6% to 33.8% – a fall of approximately three percentage points greater than that experienced by the US.

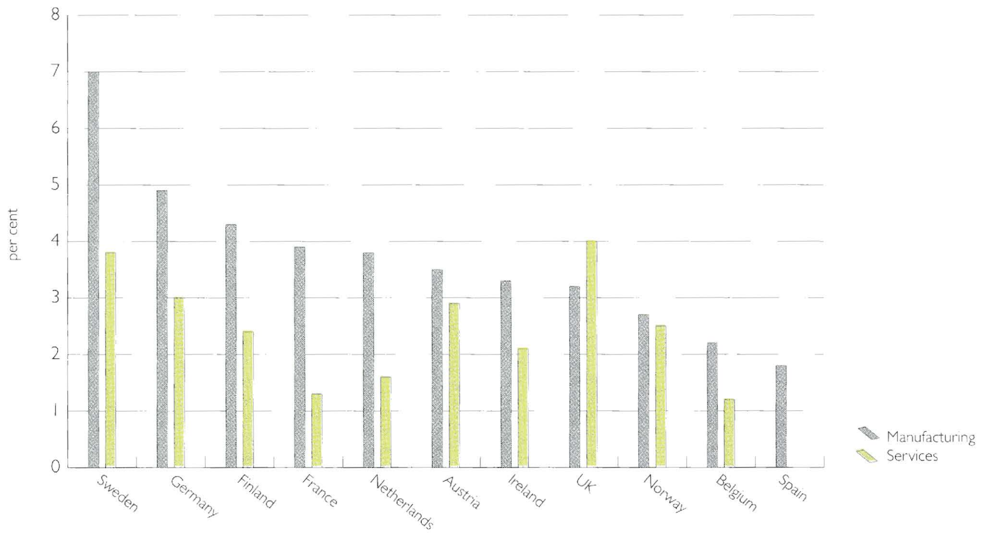
Flows of disembodied knowledge – as opposed to that embodied in products and services – can be indirectly assessed using data on patenting activity, since foreign patents may also be used to sell new technologies into non-domestic markets in disembodied form, as licences. Since it outstripped growth in industrial R&D expenditures, the robust worldwide expansion of external patent applications in the decade 1985-95 indicates increased efforts to exploit innovations in overseas markets. European companies participated in this trend, but remain disadvantaged by the fact that in order to exploit their innovations across the wider 'domestic' Single European Market they must bear the cost and complexity of dealing with different national regulations and courts.

In the three largest EU economies, foreign multinational enterprises account for between 13% and 15% of total industrial R&D expenditure, but from 21% to 28% of industrial production. These figures are not significantly different from those for the US, where foreign multinationals account for 11.3% of R&D and 15.5% of production. However, the overseas R&D activities of European firms are heavily concentrated in the US (Figure 1.8), where they

Innovation expenditures as a percentage of sales, by country

Source: OECD STI Scoreboard 1999

Figure 1.10



represent almost 70% of all foreign-controlled R&D. Indeed, there is evidence that when European firms locate their R&D in foreign countries, they prefer to do so in the US rather than in another EU country. In the period 1990-95, 53.1% of patents resulting from the research activities of European companies outside their home countries originated in the US, and only 40.4% in Europe (Figure 1.9).

Service sector innovation

Data on innovation activities in the service sectors are still patchy, both geographically and sectorally. Nevertheless, it is clear that innovation is by no means solely the preserve of manufacturers. At 66%, the proportion of innovating firms in Germany's 'modern' service sectors is precisely the same as the proportion in its manufacturing industries – and 'traditional' service sectors do not lag far behind, with innovators having a 56% share.

However, while innovation expenditure represents around 5% of turnover in manufacturing, in the service sectors it is typically only 1% (Figure 1.10). Outside the information technology industry, R&D is insignificant in the service sectors, with non-research-based innovation playing a correspondingly larger part. In particular, in the service sectors, human capital – and to a lesser extent the acquisition of knowledge embodied in capital goods – appear to replace R&D as the main inputs for the development and implementation of innovations.

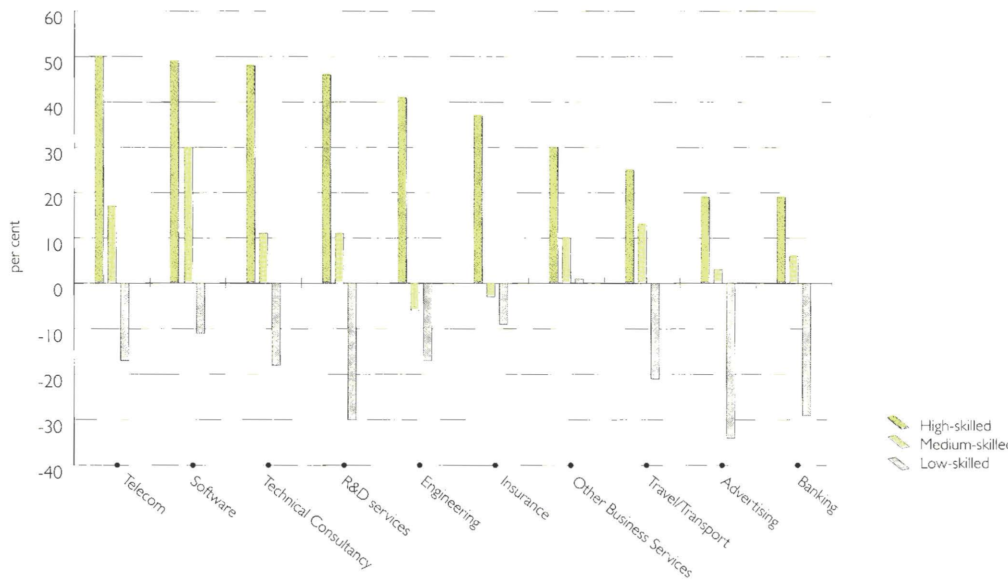
Among the new technologies employed by service sector firms in their own product or process innovations, information technology (IT) plays a dominant part. In every German service industry, the great majority of innovating firms depended on IT investments – from 87% in the retail trade to 100% in the telecommunications sector.

In all service sectors, and especially in those which rely particularly heavily on IT, innovating firms employ a significantly higher proportion of high-skilled and medium-skilled staff. Reaping the full rewards of investment in IT appears to require complementary, and often prior, investment in human capital. Indeed, as a proportion of total innovation expenditures, spending on staff training is considerably higher among service sector innovators than among those in the manufacturing industries. However, Italian data suggest that training investment tends to be concentrated on the most highly qualified personnel, with few resources devoted to training for low-skilled workers (Figure 1.11).

Service sector innovation is predominantly based on tacit knowledge stored in the brains of employees and in partially undocumented business and management procedures. Customers, and other firms in the same industries (including competitors), are more important as sources of the information on which innovation is based than in the manufacturing sectors. Intellectual property rights are more difficult to acquire and to defend than in manufacturing industry, so successful innovations tend to spread rapidly through imitation. However, this also reduces the incentive to innovate, since the ease with which a new product can be copied limits the potential return on investment in its development.

Impact of innovation on the skill structure of Italian service industries, 1993-95
(net share of companies expecting increases/decreases per skill group)

Figure 1.11



Intellectual property rights

Patents stimulate innovation in two ways. First, they create an incentive to innovate by giving an inventor a temporary monopoly to exploit a specific new technology. Second, patents require patent-holders to publish details of their inventions. This accelerates the dissemination and application of new knowledge by enabling others to build on the current state of the art, as well as improving the efficiency of economy-wide innovation by minimising the duplication of effort.

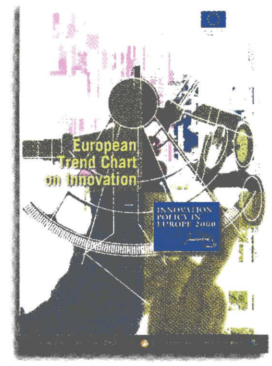
Disproportionate reliance on secrecy and speed-to-market as a means of protecting intellectual property, rather than on patents, has long been suspected as a major contributor to Europe's relative failure to commercialise and capture value from its scientific and technological creativity. Factoring out differences in the rate of invention, and in industry structure, to arrive at rough 'patent propensity rates' for Europe and the United States, it appears that 44% of European product innovations and 26% of European process innovations are patented, while the corresponding figures for the US are 52% and 44%. It seems probable that European firms do indeed patent less than their American counterparts.

In the realm of product innovation in particular, European firms consider speed-to-market to be twice as important as patents as a source of competitive advantage. US firms, by contrast, consider it to be less than 1.5 times as important, while in Japan it is hardly thought to be more important at all. A similar, although smaller, discrepancy is found in the field of process innovations. With the exception of small high-tech firms in the fields of biotechnology and software, where adequate protection of intellectual property is essential in attracting venture capital, the importance attached to patents falls as company size decreases – SMEs make the least use of the patent system. In seven European countries in 1993, 38.2% of innovative firms with over 1,000 employees stated that patents were 'very important' or 'crucial' to their ability to maintain competitive advantage, compared to 20.6% of those with fewer than 100 employees.

It is also uncertain how effective patents are as a means of diffusing new knowledge – the second innovation function theoretically performed by the patent system. Patent databases clearly have some way to go before they become genuine clearing houses for new knowledge, although the internet is now rapidly increasing the accessibility of patent information. In this respect, too, SMEs seem to make least use of the patent system. While 34% of large R&D performing firms use patent disclosure as an information input to their innovation activities, only 18% of those with fewer than 500 employees do so. Among small companies which do not perform R&D, the proportion falls to 6%. These figures compare with the 50% of all small companies which consider trade fairs, suppliers and customers to be important information sources.

1.3

European Trend Chart on Innovation: Innovation Policy in Europe 2000



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Key Findings

- EU Member States still devote considerable efforts to the three **traditional innovation policy levers** of research programmes, measures to stimulate innovation financing, and special help for innovating SMEs.
- Three areas of action are emerging as **new priorities** – industrial-academic interfaces, clustering and networking, and the creation of new technology-based firms (NTBFs).
- While countries with weak **private R&D** employ general programmes and tax incentives, those with stronger private R&D tend to target specific types of companies, specific industrial sectors or strategically important technologies.
- Growing emphasis on the dual role of the private sector as technology user and as translator of market needs into research problems has led to the emergence of the **science-industry interface** as a new focus of policy initiatives.
- In most Member States, innovation finance policy has paved the way for broader policies designed to support the **creation of new high-tech companies**.
- Policy-makers are beginning to back practical targeted innovation support programmes and schemes with reforms of the larger **legal and administrative framework**.
- There is a widespread shift from support for individual companies to measures supporting **consortia**.

The Trend Chart was launched in 1999 as part of the Innovation and SMEs programme of the EU's Fifth Research Framework Programme. Experts in each Member State continuously gather information about national measures designed to stimulate or facilitate innovation. The work focuses on four key areas – financing, protection of intellectual property, the creation of high-tech start-up companies, and the transfer of new technologies from the research base to industry. Its aim is to provide policy-makers and managers of innovation support schemes with summarised information and statistics on innovation policies, performance and trends in the EU. It will also form the basis for the benchmarking and exchange of policy good practice in the area of innovation.

Innovation Policy in Europe 2000 outlines the current position in each Member State, summarising the substantial report produced by the Trend Chart's pilot phase, which was completed in 1999.

Innovation's technological, economic and social dimensions make it a complex process, and policies and measures designed to foster and encourage it are of a variety of different kinds. They may be broadly based, touching many aspects of the process, for example, or may target specific problems requiring particular attention. The Trend Chart project uses the structure of the European Commission's 1996 *First Action Plan for Innovation in Europe*(1) as a framework for the classification and analysis of innovation policies and schemes. This employs a system-based approach to innovation, which acknowledges the diversity and interdependence of the components that make up an 'innovation system' – which include the educational system, the regulatory, legislative and fiscal framework, the competitive environment, the legislation on patents and intellectual property, the research infrastructure, and innovation support services, as well as research centres and companies.

In summary, the 1999 data show that EU Member States still devote considerable efforts to the three 'traditional' policy levers of:

- support for research carried out by companies
- schemes to stimulate adequate financing for innovation
- special help for small and medium-sized enterprises (SMEs) to absorb new technologies and to manage innovation

In addition, three areas of action are emerging as new priorities:

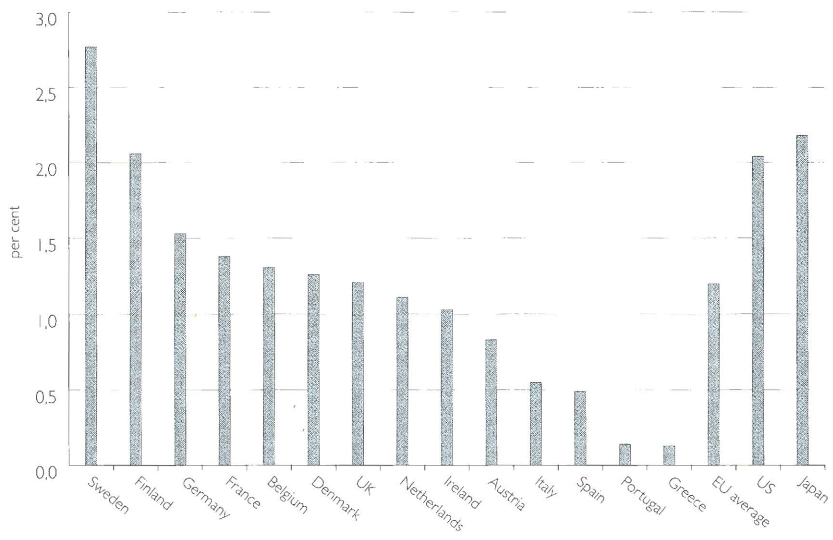
- co-operation between research centres, universities and companies
- clustering and other forms of co-operation between innovation actors
- the creation of new technology-based firms (NTBFs)

(1) COM(96) 589 final.

Business expenditure on R&D as a percentage of GDP, 1998

Source: Eurostat

Figure 1.12



Support for industrial research

Private sector research and development is an important indicator of national innovation capacity (Figure 1.12), and Member States employ a variety of approaches to boost performance. Those whose private R&D is weak tend to adopt more general programmes and tax incentives, while countries with relatively strong private R&D may implement selective measures, targeting specific companies – such as start-ups, SMEs or research-intensive firms – specific industrial sectors or strategically important technologies.

In several Member States, tax measures have for some time been used to stimulate private R&D. A successful scheme in the Netherlands, for example, allows firms to make reduced income tax and social security payments for R&D employees. The simplicity of the scheme's administrative procedures makes it especially attractive to SMEs, which in 1998 received 60% of its overall budget. Use of the scheme has grown from 5,000 companies in 1994, the year it was introduced, to 14,600 in 1999. An evaluation in 1999 showed that participating companies spend more on R&D than those which do not. The number of R&D employees also increases among scheme users.

Technology absorption

Enhancing the capacity of SMEs to absorb technology (Figure 1.13) is another traditional pillar of innovation policy. This is a demand-led approach, and focuses on the transfer of 'tacit' know-how and on physical proximity to sources of new technology. Science parks, regional technology centres, industrial liaison offices (ILOs) and demonstration projects are the most widely employed vehicles.

A large number of Member States operate programmes to stimulate SME demand for new technology by supporting assessments of firm-level technology needs. Finland, for instance, successfully applies this approach through the Technology Clinic Initiative and the Technology Strategy Consulting Services for SMEs scheme. Sweden has developed a multifaceted scheme which combines the creation and funding of company networks, support for technology brokers, and the application of advanced information and communications technologies. Launched in June 1999, the TUFF programme encourages trade in technological services between public R&D technology providers and groups of SMEs. It stimulates SME demand by supporting feasibility studies, inter-firm networking, and co-operative projects.

Industrial-academic interfaces

National policy-makers are increasingly abandoning the false distinction between 'upstream' measures to stimulate R&D and 'downstream' measures to aid technology absorption. There is a growing emphasis on the dual role of the private sector as technology user and as translator of market needs into research problems. This has led to the emergence of the science-industry interface as a new focus of policy initiatives. Following the systemic approach to innovation policy, Member States are starting to address performance problems with schemes designed to bridge the cultural, institutional and information gaps between the performers of research in the public sector and those who take up the results in the private sector.

This need not imply the introduction of totally new measures, but rather a redefinition and better integration of existing instruments. In the UK this has included, for example, a substantial increase in the budget allocated to the Teaching Company Scheme (TCS) – one of Europe's pioneering mobility programmes – as well as the launch of a series of complementary measures.

TCS's goal is to increase interactions between the higher education sector and business and industry, enabling firms to take advantage of the scientific, engineering, technological and business management skills and knowledge available in universities. It subsidises two-year placements of highly qualified recent graduates to work on projects central to the host companies' needs, under the joint supervision of university and company staff. SMEs make up 90% of the participating companies, and generally pay only 30% of the direct costs – approximately €1,600 per graduate per year.

In several countries, mobility schemes are being reshaped as two-way instruments, and R&D subsidy schemes redesigned to intensify collaboration between research centres, universities, groups of enterprises and individual companies. Measures fall into two categories – nation-wide technology-specific 'competence networks', and regional 'technology valley' schemes. The latter type in particular is gaining considerable momentum. In Flanders, regional authorities are promoting research-industry collaboration around research and training institutions. Other examples include the Irish 'Atlantic Universities Alliance' and the 'TechGate Vienna' initiative in Austria. The dangers of fragmenting public support and of stimulating inefficient competition between regions are, however, inherent in this increased regional emphasis, especially in countries where decentralisation is still in its early stages.

Financing innovation

Since the early 1990s, most Member States have increasingly sought to complement direct funding for research by in 1999 channelled €750 million of venture capital to young technology-based firms.

In the Netherlands, special facilities for new technology-based firms (NTBFs) were recently withdrawn – government guarantees designed to stimulate venture capital investment in high-risk, high-tech firms had done little to reduce the funds' aversion to risk. The scheme has now been replaced by more targeted seed and growth funds.

Spain, meanwhile, has extended fiscal incentives for research to cover innovation activities as well. For the first time, a 2000 law includes innovation costs among the deductible R&D expenditures (renamed R&D&I). This new approach covers innovation projects undertaken in collaboration with universities and the technology centres of public research institutes, as well as the acquisition of advanced technology in the form of patents, licences, know-how and designs.

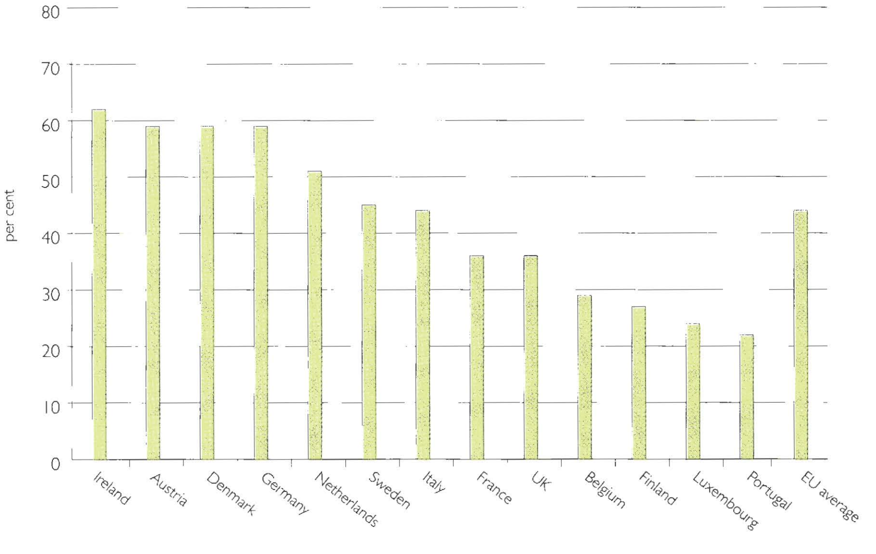
Creation of innovative firms

In most Member States, innovation finance policy has paved the way for broader policies designed to support the creation of new high-tech companies. In parallel with the mobilisation of risk capital, typical measures include entrepreneurship

Figure 1.13

Share of manufacturing SMEs that innovate in-house, 1996

Source: Community Innovation Survey



promoting private innovation financing (Figure 1.14), mainly at the early stages of the innovation process.

Available venture capital is increasing in Belgium, for example, especially in Flanders where the take-off funds, Sogepa and Brustart, focus on seed capital investments, rather than on specific industrial sectors. Interestingly, universities play an active role in providing risk capital for new spin-off companies established to exploit the results of academic research. In Sweden, new measures include the seed financing fund operated by Nutek which targets small high-tech companies, and the Nutek Investment Forum CapTec – an annual investment forum for young technology-based firms. In Germany, the central pillar is the BTU programme, which

training in public research and higher education institutions, assistance for technology transfer and licensing, and the creation of 'incubators' offering a favourable environment and tailored advisory services. Start-up policies increasingly adopt a 'systemic' approach, often oriented around technology valleys and aligned with wider reforms – notably, the French 'Innovation Law' of 1999.

The traditional culture of the French education and research system strongly discouraged entrepreneurship among researchers, who have been viewed as civil servants. Innovation financing focused exclusively on the later 'downstream' stages of the innovation process, to the detriment of feasibility studies, incubation and start-up. The 1999

Innovation Law tackles these problems with a range of integrated policy measures.

To facilitate the creation of companies by young researchers, it allows universities and public research institutes to continue to pay them a salary during the start-up phase, and to offer certain risk guarantees. The founders are also allowed to become members of the board of the new company and to take up to 15% of its shares. Universities and public research institutes are encouraged to create incubators and commercial offices, and the law facilitates joint ventures between the public and private sectors.

The German federal government's Exist programme aims to improve the climate for the creation of spin-offs from universities, and supports several regional networks of universities, research institutes, venture capitalists, private companies and consultants, chambers of trade and commerce, science parks and business centres. Five regions were selected for support from an overall budget of around €15 million per year. The programme is accompanied by a 'virtual academy' for new entrepreneurs, a newsletter, a seed capital fund and an action research programme. The programme has already had considerable impact on the German high-tech scene, even in those regions not selected for direct support.

Another widely used approach is to organise contests and award schemes for young entrepreneurs. In France, a national competition for the creation of new technology-based firms was organised for the first time in 1999. Austria has a long-standing state award for innovation, which has now been complemented by a 'Young Innovator Scheme'. Awards are also used in Finland, where the prestigious annual Innosuomi prizes recognise exceptional creativity and entrepreneurship.

Protecting intellectual property

With knowledge playing an ever more significant role in the economy, the ownership and commercial exploitation of new knowledge has become a core issue for enterprise and innovation policy. A variety of measures aims to strengthen the management and protection of intellectual property rights, and schemes to provide additional support to innovating companies using patents and the patent systems have become quite common.

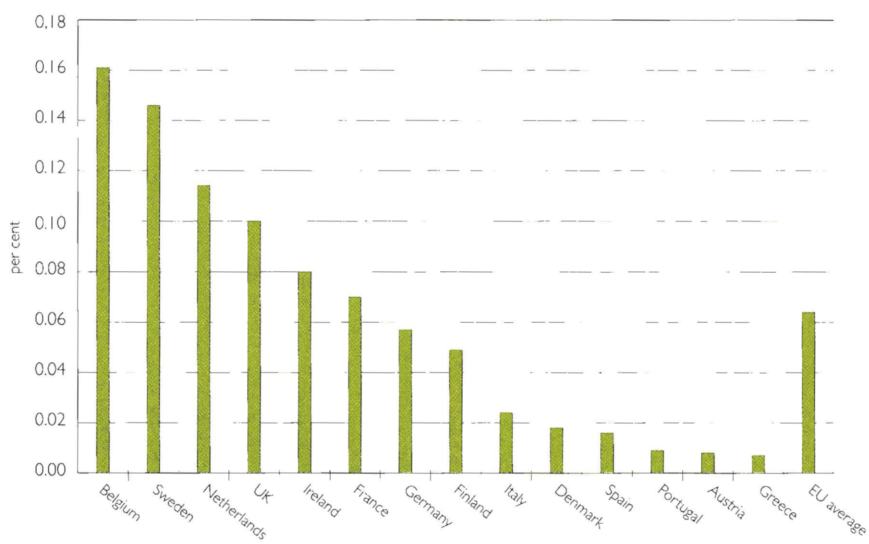
In Germany, an 'Innovation Market' provides an innovative web-based platform linking investors to patent holders and young technology-oriented firms. In Belgium, several schemes offer financial support for firms wishing to explore patenting possibilities, to use patent databases, or to acquire IPR and advice, and a national awareness campaign has been launched.

Poor awareness of intellectual property issues has prompted the Spanish Patent Office (OEPM) to promote and fund a knowledge-diffusion campaign for intellectual property matters, and it also offers grants for training in IPR issues. In Portugal, where financial support for patent registration is available, the national patent office (INPI) has been restructured to strengthen its links with the technological infrastructure so that it can promote patenting more proactively. In Ireland, IPR measures are focused on the high-growth software and multimedia content sectors, where the Copyright Bill will streamline the protection and licensing of IPR.

Figure 1.14

Venture capital investment in technology firms as a percentage of GDP, 1999

Source: EVCA/PWC



An innovation-friendly environment

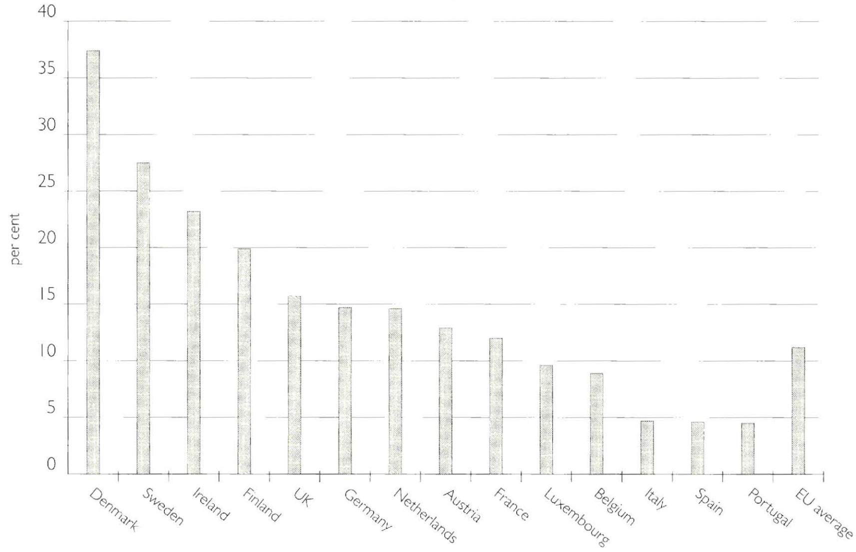
Adopting a more systemic approach, policy-makers are beginning to back practical targeted innovation support programmes and schemes with reforms of the larger legal and administrative framework at the national level – as exemplified by the French Innovation Law of 1999, described above.

Germany's federal government has taken a similar path, initiating step-by-step reform of the legal and administrative framework for public research. By bundling a number of legal and administrative reforms into 'package laws', the government hopes to increase both their political impact and, in the longer term, their influence on the attitudes and behaviour of practitioners – or, in other words, to effect a shift in the national 'innovation culture'.

Figure 1.15

Share of SMEs involved in innovation co-operation, 1996

Source: Community Innovation Survey



Clustering and co-operation

The establishment of networks and clusters, and the interaction and knowledge flows within them, are being given increasing priority in most Member States (Figure 1.15). Some countries still tend to encourage more traditional bilateral collaboration and consortia building, while others target broader, less formal collaboration within and between sectors. But the shift from support for individual companies to measures supporting consortia is now a general trend.

In the Netherlands, clustering is a key element of innovation policy. The public sector performs a dual function – first, as a broker for strategic information and contacts between actors, and second, as a sophisticated public customer, using procurement policy to stimulate collaboration between contractors. In Sweden, programmes such as the 'Regional Technology Programme', 'New Liaison Functions' and 'Technology Transfer for SMEs' all support cluster and network development.

The Irish Inter-firm Co-operation Network, which was successfully piloted in 1996, is now a major focus in the National Development Plan 2000-2006. Designed to increase both science-industry linkages and inter-firm relationships, it is modelled on the Danish Industrial Network Programme, providing an excellent example of European transferability.

A society open to innovation

Many countries have created 'innovation councils' or extended the role of conventional science councils to address innovation. Many consider high-level co-ordination structures to be crucial in cutting through 'territorial' competition between ministries, while Germany and Spain have initiated major redefinitions of ministerial competencies.

Mobilising economic and social dynamism is also high on the policy agenda in all Member States. Italy has established an 'Information Society Forum' to co-ordinate the drafting of the National Information Society Action Plan, with a special task force to co-ordinate the contributions of different ministries and the role of the various public administrations involved. It publishes a newsletter and operates a website as a working forum for public institutions, enterprises, trade unions, universities, research bodies, associations and private citizens.

Mobilising the innovative capacity of any society requires a strategic vision shared by all relevant stakeholder groups. Traditional technology foresight exercises have increasingly been opened up from the 'inner circles' of scientists and industrialists to include contributions from a wider public. National parliaments have often played a pioneering role by setting up technology assessment offices to anticipate and influence the impact of new technologies. Politically neutral not-for-profit organisations and 'Innovation Foundations' receive public support in countries such as Belgium and Spain.

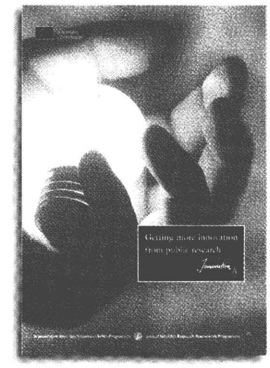
chapter 2 **Technology Transfer**

2

The processes by which the outputs of scientific and technological research reach developers and end-users are varied and complex. Large public research institutes have traditionally focused on fundamental science, but are becoming more entrepreneurial in seeking applications for their work. Meanwhile, specialised high-tech start-up firms are increasingly collaborating with universities and research institutes, with larger companies and with one another, both as users and as suppliers of new technologies.

2.1

Getting more innovation from public research



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Free, from the Innovation Helpdesk (see back cover)
or downloadable from
http://www.cordis.lu/innovation-smes/src/studies.htm

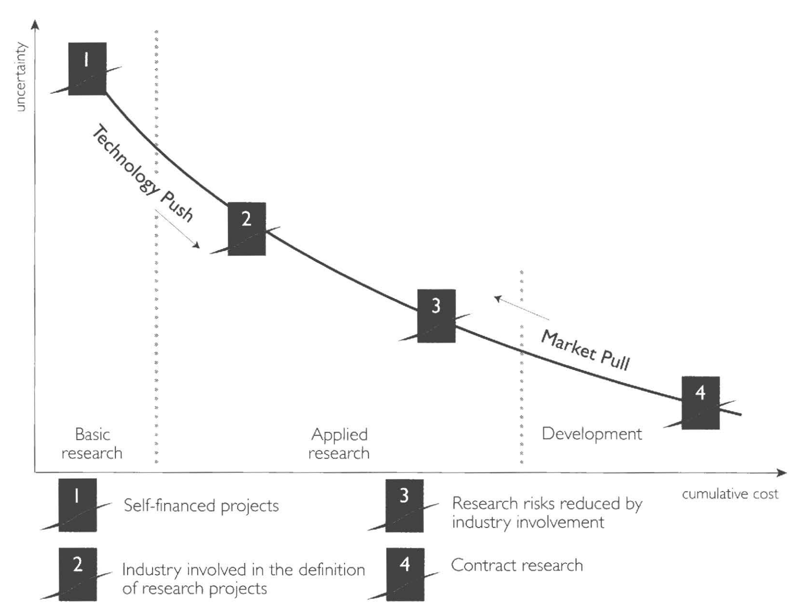
Study team led by: Arthur D. Little International Inc. (Germany)

Key Findings

- Most large public research institutes (LPRIs) now have explicit technology transfer objectives. There is no inherent incompatibility between **basic research and technology transfer**, but the relationship between the two activities must be made explicit, and managed.
- The ability of a country's LPRIs to **interact** efficiently with industrial research and development efforts is an important determinant of overall national innovation capacity.
- LPRIs must learn about the **real needs of firms**, and of SMEs in particular, but may require funding incentives, since small firms are often unable to finance collaboration directly.
- **Mobility of staff** between LPRIs and industry is vital, but new employment and human resource management policies are needed to address the significant practical barriers to such exchanges which persist.
- LPRIs' ability to deliver services that genuinely facilitate commercially successful transfers of knowledge demands the **elimination of rigid and bureaucratic rules** and procedures.
- **Spin-off companies** can offer the most efficient route to commercial exploitation of a new technology, but researchers need support to secure financial and marketing competences in order to build an effective management team.

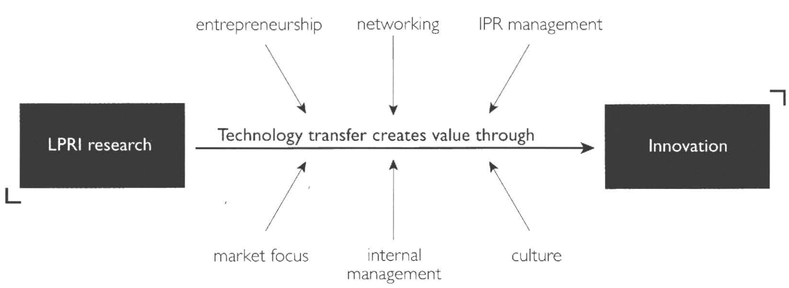
Strategic planning tool for positioning technology transfer activities

Figure 2.1



Six areas of good practice in LPRI technology transfer

Figure 2.2



Large public research institutes (LPRIs) vary very widely in respect of the resources and effort they devote to technology transfer. Depending on their specific circumstances, and the balance struck in their missions between the needs of government authorities, national industries and other stakeholders, their activities may be primarily in the area of basic or strategic research, or alternatively may focus on contract research and the development of applications.

However, whether or not technology transfer is among an LPRI's primary tasks, it is at the very least a significant and valuable by-product of its work, and most LPRIs now have explicit technology transfer objectives. CERN[1], which of all European LPRIs has perhaps the greatest focus on 'fundamental' research, nevertheless created the underlying technology of the World Wide Web – perhaps the most far-reaching example of technology transfer ever seen.

Getting more innovation from public research acknowledges the diversity of LPRIs, but starts from the premise that there is no inherent incompatibility between basic research and technology transfer. On the other hand, it contends that the relationship between the two activities needs to be made explicit and to be managed (Figure 2.1). Institutes must develop a culture in which each is appropriately recognised, valued, supported and rewarded, and where neither is undermined by ambivalence or vacillation on the part of senior management. Just as in the world of commercial research and development, each LPRI must adopt a systematic 'portfolio' approach to its research strategy, in which a clear balance is established between long-term and short-term, and between low-risk and high-risk, research goals.

The report makes no attempt to define a single model of technology transfer good practice which all should follow, but identifies six areas of good practice relevant to all LPRIs, in which benchmarking could improve performance (Figure 2.2). It also describes a number of tools and approaches for technology transfer which all (or almost all) will find useful. However, it recognises that the balance accorded to each area of good practice, and the use made of each tool or approach, will vary from case to case. Finally, the report develops a series of recommendations for policy-makers, for LPRIs themselves, for industrial partners, and for educators and other transfer partners – and in particular a detailed proposal, called the European LPRI Benchmarking Initiative 2000, for the creation of a benchmarking group.

LPRIs and innovation policy

Whatever their original missions, most LPRIs now recognise that their present function goes beyond the traditional role of advancing science and generating know-how in emerging technological areas. Today, it also encompasses the promotion and diffusion of new knowledge, and support for its successful conversion into competitive products and services. Indeed, the strength of a country's LPRIs, and their ability to interact efficiently with industrial research and development efforts, is an important determinant of overall national innovation capacity.

LPRIs contribute in three ways – first, by providing ideas and information as the basis for the development of new products, processes and services; second, their pursuit of long-term research goals advances the state of the art in new areas of knowledge and serves as a training ground for highly qualified staff; third, their ability to forge connections between specific research fields strengthens the broader national and EU scientific and technological base.

LPRIs can act as bridges between universities and industry, but to do so effectively they must learn about the real needs of firms – and of SMEs in particular. They may also require funding incentives, since small firms are often unable to finance such collaboration directly. Similarly, LPRIs can facilitate network and cluster development and provide skilled support for the consultants who deliver some of the most successful small company assistance schemes. In many cases, recent reductions in government funding for nuclear and defence research has led to the adoption of a more market-oriented approach, facilitated by the relaxation of regulatory constraints. On the other hand, private research centres are likely to resent any suggestion of unfair competition from 'subsidised' public research bodies, while researchers themselves are wary of possible dilution of LPRIs' basic research capacity.

(1) The European Organisation for Nuclear Research

In some areas of their mission, it is more appropriate to consider the role of an LPRI in relation to regional industrial networks and clusters, than as contributors to national innovation systems. Alongside universities, LPRIs appear well-equipped to support cluster dynamics, and to provide resources of knowledge and skills on which clusters of nearby companies can cost-effectively draw. Mobility of professional staff between industry and the research base is clearly vital, but enlightened human resource management and more flexible employment policies are needed to address the significant practical barriers to such exchanges which persist.

European policy-making is increasingly adopting a system-based approach to innovation, placing a greater emphasis on networking, on venture capital, and on support for the creation and growth of innovative firms – and according a correspondingly lower priority to the funding of high technology research. LPRIs must adapt to these changing circumstances, but the new environment presents them with opportunities as well as threats.

nesses, offering incubation services to help LPRI researchers to commercialise research results through a start-up firm.

A wide range of technology transfer instruments and channels has been developed, as a means for institutes to interact with regional and national innovation systems. By employing less traditional communication channels such as the technical and trade press, and trade fairs and exhibitions, for example, LPRIs are able to present their achievements to industry as well as to scientists, and at the same time to gather valuable intelligence about industrial and commercial needs and trends.

In almost all LPRIs, transfer departments have been set up during the past decade. Some proactively market their institutions' technologies and technological capabilities, while others still perform a largely administrative function. However, the challenge of delivering services that will genuinely facilitate commercially successful transfers of knowledge demands the elimination of rigid and bureaucratic rules and procedures. Some LPRIs have found it easier to develop the necessary entrepreneurial spirit and dynamism in a newly-established 'arms-length' organisation than in an internal department.

The LPRI technology transfer 'value chain'

Figure 2.3

Value Chain	Mission	Examples
1 Research and technology policy	Create the right environment for successful technology transfer	• standards definitions • advice to government
2 Creation of knowledge	Advance scientific knowledge	• research programmes – scientific excellence as prerequisite for LPRI research centres
3 Transfer of knowledge	Make critical know-how available early	• staff transfer • publications • seminars
4 Transfer technology	Provide building blocks for competitive advantage	• transfer of research results • patents and licences
5 Development services	Contribute to industrial partner's creation of new products	• contract development • co-development
6 Business creation	Develop new business out of research context	• incubator function • venturing and spin-outs

From research to spin-offs

The technology transfer 'value chain' (Figure 2.3) does not represent a linear process, but highlights the different components of knowledge transfer from LPRIs. Although the emphasis which each LPRI places on individual components will differ, most will be active to some degree at all points along the chain.

Traditionally, knowledge transfer has primarily used publications, conference papers and other established channels of scientific communication. In the 1990s, staff transfer has grown in importance, as collaboration with industry has increased, and as LPRIs have employed more staff on a part-time or temporary basis. But knowledge transfer, in all but the narrowest sense, requires subsequent adjustment and refinement of the technology transferred to meet the needs of the end-user. Many LPRIs have started to deliver such development services – even though this work is outside the realm of 'pure' science, and requires new management competences. Most also promote the creation of new busi-

Leading research institutions in the United States have had spectacular success in creating spin-off companies, which has in some cases provided the catalyst for rapid regional economic development. This has prompted intensive efforts throughout Europe to improve performance in the creation and growth of such high-tech start-ups. Spin-off companies founded by researchers can offer a faster and more efficient route to commercial exploitation of a new technology than transfer to an established larger firm – where it may be delayed or abandoned due to institutional rigidities. But researchers rarely possess all the necessary business skills, and support is needed to secure financial and marketing competences in order to build an effective management team.

Contract research, partnerships and joint ventures offer less widely used alternatives to the creation of spin-offs as a means for LPRIs to contribute to economic development. Knowledge commercialisation strategies may also be based on the exploitation of intellectual property rights (IPR) through patenting and licensing – but here, supporting services are essential to ensure effective transfer of tacit knowledge components not contained in patents themselves.

The selection of suitable technology transfer instruments is itself a key skill for LPRIs. The correct choice in the case of any specific technology depends not just on the objectives of the partners, but also on the industry concerned and the phase of the technology's lifecycle. Spin-offs, for example, may be appropriate in the development phase and in an emerging industry, where both risks and potential returns are high. In more mature industries, by contrast, spin-offs are much less likely to be able to challenge the dominance of established market leaders.

Six key areas

Six areas of management focus, in each of which LPRIs should seek to identify and implement appropriate best practice, appear to be critical.

The first of these is **market focus**. Successful technology transfer requires LPRIs to identify and orient their activities towards the needs of their customers, and to adapt their organisational structures so as to encourage and manage this commercial orientation. Potential applications and customers must be proactively identified by multi-disciplinary teams combining technical, marketing and business expertise. Depending on the needs of target customer groups, accompanying services may need to be developed and delivered in parallel with the flow of technologies.

The second area is **organisational culture**. Changing the culture of an LPRI traditionally rooted in basic scientific research is a long and difficult process. It cannot be effected without real commitment from senior management, articulated in appropriate managerial methods and style. Suitable organisational arrangements also need to be introduced in order to make the technology transfer mission of scientists, researchers and engineers clear and explicit, give them sufficient incentives to fulfil it, and remove obstacles to entrepreneurial creativity and initiative. Active, organisation-wide communication of the technology transfer mission is absolutely essential.

A revitalised organisational culture needs to be reflected and supported by **internal management** structures and procedures. Effective knowledge management within the institution is essential, and communication blockages at all levels must be identified and removed. To improve efficiency, enhance customer satisfaction and reduce internal resistance to technology transfer, project management procedures and skills must be strengthened (Figure 2.4). Training schemes and quality management systems must be introduced, and industrial links strengthened through programmes of short-term staff exchanges.

Next, active **IPR management** is necessary to maximise financial revenues and ensure customer satisfaction. A clearly stated strategic IPR policy, supported by appropriate training and information-sharing activities, is essential. There must also be an incentive system which adequately rewards IPR activity. Lastly, the channelling of resources through a specific licensing or technology transfer is a basic condition for effective IPR management.

The fifth area of management focus is **networking**. Successful innovation demands active management of the interactions between LPRIs and the other stakeholders in the transfer process – industrial firms, universities, investors, users and public authorities. Efficient networking, both internal and external, requires mutual understanding and trust, and sufficient resources and time must be made available to ensure that this develops.

The final area on which LPRIs need to focus is **entrepreneurship and new business creation**. In recent years, these have emerged as highly efficient methods of bringing knowledge generated by research to the market, while they also produce new wealth and jobs among other social benefits (Figure 2.5). The most promising approaches to entrepreneurship are based on networks which bring together complementary local experts to provide a comprehensive and affordable package of guidance and support services to would-be entrepreneurs. LPRIs themselves frequently act as references for new spin-off companies, and in some cases provide seed or development capital, either directly or indirectly.

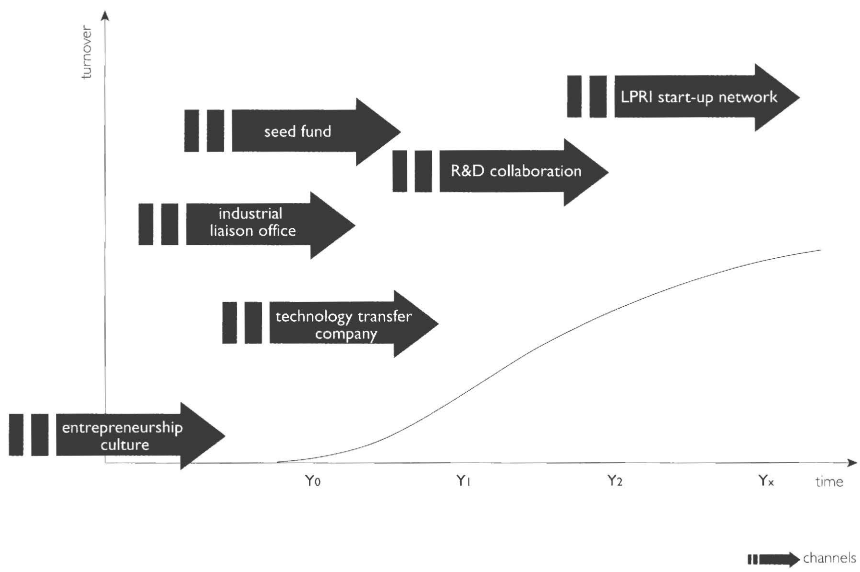
Effective project management for LPRI technology transfer

Figure 2.4

Steps	Project preparation	Realisation of the project	Finishing the project	Feedback and follow-up
Principles	• transform project idea into explicit plan • marketing efforts • financial arrangements • contract negotiation	• initiation • implementation • revision of plans if needed • cost control • quality assurance	• performance of agreed tasks • overview of the project • assessment of final results	• customer feedback • agreement between partners on follow-up • project evaluation • dissemination activities (e.g. seminar, press conference)
Who?				
Project Manager	+	+	+	+
Steering Group	+		+	+
Project Team		+	+	+
Input	• formation of steering group • project responsibilities statement • kick-off meeting	• definition of project members' responsibilities • steering group to monitor progress	• final meeting • internal review • project evaluation	• evaluation and review • project debriefing
Key success factors	• define project members' responsibilities	• involve project members	• ask for customer feedback	• map knowledge and experiences

Model of LPRI support for entrepreneurship

Figure 2.5



Benchmarking

Benchmarking does not appear to be a widely used management tool among European LPRIs. Some have already initiated a process of performance comparison against organisations perceived as 'best in class', but this falls short of a benchmarking approach specifically designed for LPRIs.

Benchmarking is a continuous process. It leads to better understanding of the organisation's current practices, and makes use of systematic comparison of practices and performance with those of others to develop improvement actions which will bring performance levels up to or beyond those of the 'best in class'.

In assessing the performance of the LPRI technology transfer process, managers have conventionally employed a series of predominantly financial indicators – external revenues, overhead costs, royalties and so on. Such indicators are, however, both narrowly focused and backward-looking. A more useful, and more balanced, set of indicators may be developed in relation to the twin dimensions of 'time focus' (from the impact of past inventions to the prediction of future directions) and 'process phase' (from the input of new product ideas to the output of successful commercialisation).

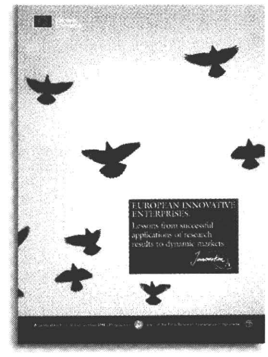
Such indicators should inform strategic management by revealing the gap between current and desired technology transfer performance, and providing a yardstick against which to measure progress. They should address both short- and long-term time horizons, promote transparency between functions, provide the basis for reviews of individual and team performance, and serve as a framework for project and programme evaluation.

Benchmarking references – the 'best in class' performance selected as the point of comparison for a particular function – may be drawn from within the LPRI, or from outside it. Many LPRIs choose internal references for their first benchmarking exercise, in part because information about performance has not in the past been widely shared. However, it is clear that no one institution is likely to be 'best in class' in all areas.

Systematic benchmarking promotes process-oriented thinking, increasing focus on the way things are done, and on the value of each step to the ultimate customer. It involves the whole institution in continuous problem-solving, embedding the process of change and learning, and stimulates the creation of horizontal networks which serve to integrate the organisation. It also creates responsive, customer-driven technology delivery networks. But effective implementation requires the full involvement of all levels of the organisation. Senior management must publicly support the benchmarking exercise, and communicate its progress, while driving the LPRI towards attitudes and performance which align research activities with the expectations of stakeholders. Functional departments must support research units in fulfilling their technology transfer missions, and help to bridge the gap with industry. Research units, in turn, must use benchmarking to focus on customer-oriented research by setting and achieving objectives. Finally, the assessment of technology transfer performance must be integrated with the measurement and appraisal of other aspects of the organisation's mission, and in particular its pursuit of scientific and technological excellence.

2.2

European Innovative Enterprises: Lessons from successful applications of research results to dynamic markets



English – NB-NA-17-024-EN-C, ISBN 92-828-9750-8
http://www.cordis.lu/innovation-smes/src/studies.htm
Free, from the Innovation Helpdesk (see back cover)

Study team led by: Central Research Laboratories Limited (United Kingdom)

Key Findings

- The composition and strengths of the **founding team** is a key determinant of subsequent success for new technology-based firms (NTBFs).
- In nearly three-quarters of cases, NTBFs' product development strategies address the known requirements of one or more **specific customers**. Very often, a first customer contributes to the costs of developing the product which it needs.
- NTBFs attribute their success more to the strength of their **human resources** than to 'hard' factors such as the acquisition of technology or the ability to attract equity capital.
- Many NTBFs seek to avoid the dilution of equity and loss of managerial control associated with **venture capital funding** for as long as possible. The most successful maintain financial independence through careful management of cash flows.
- They value participation in **European collaborative projects** more as a way to extend their existing technical and commercial networks than as a framework for research and development.
- Difficulties in obtaining adequate human and financial resources, and inflexibilities in employment law, tax regulations, and intellectual property rights (IPR) and standards approval systems, constitute the principal **barriers to success.**

The value of a statistical exercise such as the Community Innovation Survey (see Chapter 1), which provides an overview of innovation behaviour in Europe based on comparable firm-level data, is beyond doubt. Inevitably, however, the CIS fails to capture the dynamics of innovation activity as experienced by individual firms.

European innovative enterprises: Lessons from successful applications of research results to dynamic markets attempts to fill this gap, providing a snapshot of the experience of 50 new technology-based firms (NTBFs) which have successfully applied the results of publicly funded research. The sample, drawn primarily from the emerging information technology and biosciences sectors, was composed overwhelmingly of firms with fewer than 500 employees. Nearly three-quarters had been established for less than ten years. The report's conclusions are qualitative, but offer a framework for the statistically rigorous follow-up surveys needed to inform the design of effective policy initiatives in support of NTBFs.

In summary, on the evidence of these 50 companies European NTBFs are highly focused, address European and international markets, devote considerable attention to the acquisition and development of human resources, make extensive use of electronic communication technologies, and rely heavily on networking as a source of both technical and commercial advantage. They are also wary both of venture capital and of publicly funded research programmes, though all had received regional, national or European research and development project funding, and 40% said that their companies would not have been established without this support. They identify as the principal barriers to success difficulties in obtaining the human and financial resources they need, and inflexibilities in employment law, tax regulations, and intellectual property rights (IPR) and standards approval systems.

A firm foundation

The composition and strengths of the team which found the company is a key determinant of subsequent success – indeed, the firms themselves ranked this as the single issue with the largest impact on their development. The most important specific factor was the founders' in-depth knowledge both of the technology concerned and of the target market (Figure 2.6). However, at an early stage complementary marketing, selling, financial and analytical, and planning skills are needed to build a fully competent business team, and most of the companies hired specialists in one of these areas as their first recruits.

At the time of company launch, awareness of the target market and of the requirements of individual customers, often gained during previous employment, tends to be very high. In 64% of the sample cases, the firms saw their target market as 'closed' – they defined it in terms of the highly specific technology which they planned to offer, and relied on the uniqueness of this offer to gain entry to the market, and to defend them against competition. In the 30% of cases involving commodity products such, as internet services or mass market software, the firms were acutely aware of the competitive situation, and relied on pricing, time-to-market and superior channel management to gain a foothold. In two-thirds of cases, the founders' desire to improve on the product offering of a previous employer, or to escape from financial constraints or personal frustration experienced in that employment, was a central motivating factor. In most cases, financial reward was not the primary driver.

Product development

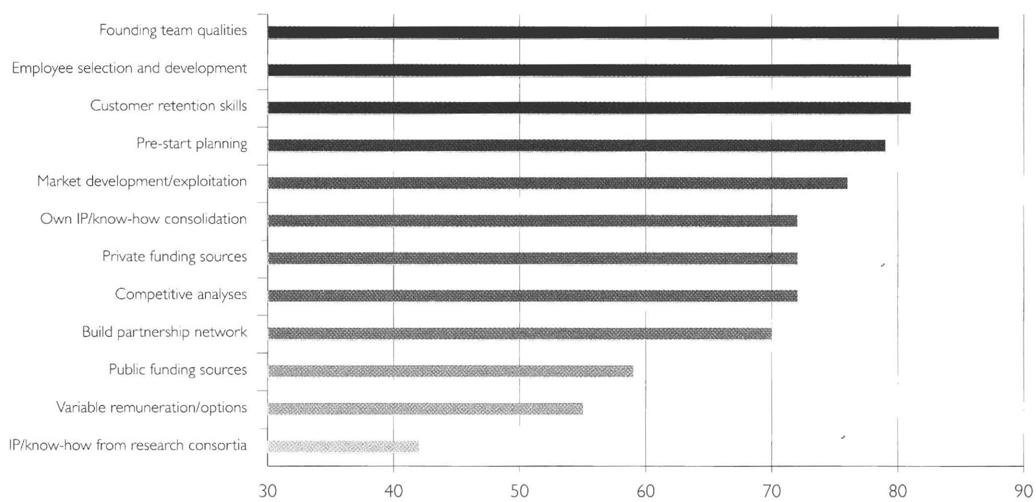
These companies' product development strategies, usually based on the exploitation of existing know-how, were in 72% of cases driven by the opportunity to meet the known requirements of one or more specific customers. In 66% of cases, the first customer provided early-stage financial support, often contributing to the costs of developing the product which it needed. More generally, these relationships seem to be a critical factor in long-term company success, serving as a valuable reference for other customers, for example. However, 70% of the sample had undertaken their initial product development as a platform for later extension or customisation which would expand the customer base and avoid long-term reliance on a single 'lead customer'. The firms which subsequently achieved the greatest financial success were those which had paid the greatest attention to establishing and maintaining a positive cash flow from the outset, thus reducing dependence on bank overdrafts or external equity finance.

Only 36% – predominantly from Italy and elsewhere in southern Europe – confined their initial attention to their domestic national markets. In a number of cases, breaking into the United States market was seen as a critical goal. These internationally-oriented start-ups anticipated much larger sales in America than in Europe, and saw direct employment of specialist US technical and sales staff as the most cost-effective means of gaining access to that market. They also believed that activity in the US would remove any perceived inferiority attached to purely European products or services.

The identity and satisfaction of early customers form the basis for the marketing 'pitch' of 70% of the firms, and are given far more prominence than either ISO 9000 quality certification or industry awards. Indeed, retaining a core of sales to long-term customers by anticipating their needs appears to be central to the marketing strategy of many – after the strengths of the founding team, this was ranked as the second most important overall factor for success. When it became necessary to differentiate themselves from competitors as they sought to expand outside their early niche, most firms sought to do so on the basis of technical superiority rather than pricing or other market factors.

Relative impact of key success factors (importance x financial contribution; 100 = vital)

Figure 2.6



Human resources

Overall, these NTBFs attribute their success more to the strength of their human resources than to 'hard' factors such as the acquisition of technology or the ability to attract equity capital. High among these 'soft' issues is the quality of the staff recruited by the firm, their induction and their subsequent training. There was broad consensus that recruiting, developing and appropriately rewarding the members of the team was one of the most critical tasks involved in the management of a small, high-tech enterprise. Seventy per cent had experienced difficulty in recruiting specialists of sufficiently high quality. This was especially the case for marketing and sales staff, and for technical staff – software, electronic and biochemical engineers in particular. Many firms reported that, even when they found applicants with the necessary skills, few were equipped for the flexible team-working on which the culture of most high-tech start-ups is based. Commonly, they blamed the educational system for its failure to prepare students for an entrepreneurial industrial environment. A significant number of firms – notably in France, Belgium, Germany and Spain – felt frustrated by tax laws which limit the percentages of shares which can be offered in stock options, and which treat options as a taxable benefit when they are received, rather than when they are exercised.

Investors and partners

Thirty per cent of the sample had attracted venture capital funding as a first step towards stock market flotation, with 10% having gone on to achieve an initial public offering (IPO). However, venture capital was widely perceived as a necessary evil. Many sought to avoid the consequent dilution of equity and loss of managerial control altogether, or for as long as possible. Indeed, the most successful were those which had maintained their financial independence through careful management of cash flows.

Much more common sources of growth finance were revenues from sales made to first customers, public funding (in 40% of cases) and private funds. Sources of private funding varied widely, from investments by founders themselves or by family trusts, to business angels, customers and suppliers, and in a very few cases local retail banks. In 30% of the firms, all the original private investors still retained their holdings, and in no case had founders yet withdrawn their equity.

The surveyed firms do not value participation in European collaborative projects very highly as a framework for research and development. However, they do value it as a way to extend their existing technical and commercial networks, and to gain access to new ones – 62% use this mechanism to supplement technical partnerships and to support market developments across Europe. More generally, for a majority networking is an essential continuing activity, to which considerable resources are devoted. Local and regional networks are very important as sources of technological collaborators and of specialist financial and legal assistance.

Management style

These companies place the emphasis firmly on vision, commitment, energy and common sense, rather than on innovative or fashionable management methods. Typically, they employ flat management structures and an 'open door' policy, stressing tutoring and personal development and a good regular flow of internal communications.

Twelve in-depth case studies reveal further features of a common pragmatic managerial approach, which is independent both of technology and of country, and covers:

- A clear **focus**, from the outset, on a particular market and a particular product or product range. In the early stage, the focus is on options based closely on the knowledge and skills of the founders, which therefore offer the best chance of commercial success.

- **Collaboration** with other companies. Perhaps as a corollary of their own specialisation, the success of many firms depended on good relationships with third parties, either for the exchange of research results (especially in the field of biotechnology), or to gain access to established sales or distribution channels. Good English language skills were considered a prerequisite for successful collaboration, as was awareness of intellectual property law.

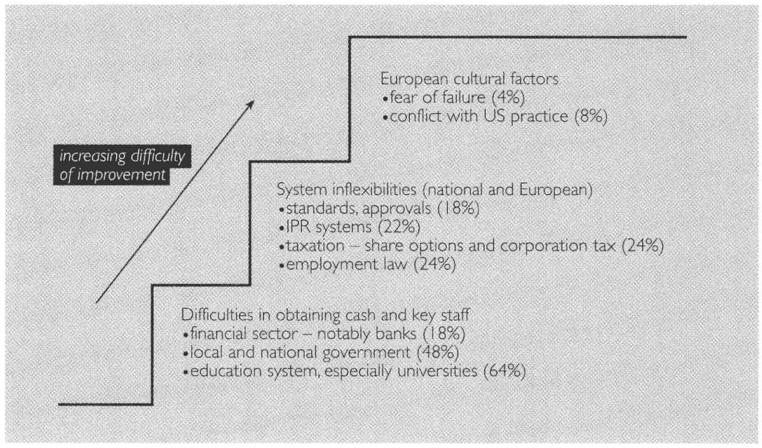
- **Customer orientation**. In a number of cases, the emphasis on customer service had led firms to establish overseas subsidiaries at an early stage, in order to be close to major markets and ensure conformity to local standards. In others, the focus was on anticipating and meeting the second-phase needs of the original customer base.

- Careful **cash management** from the beginning. Maximising cash flow was firmly entrenched in the corporate culture of a significant number of the case study companies. They saw this as a key element in their success, reducing dependence on bank debt financing and delaying the dilution of equity by venture capital at least until the company had achieved worldwide product roll-out. The negotiation of phased payments for development or serial order contracts was a widely used method.

- An emphasis on **people**. These high-growth, high-tech companies see the members of their staff teams not as employees but as key assets, carefully chosen and nurtured. Their approach to the management of human resources is positive but flexible, and they demand a large degree of both flexibility and commitment from team members in return.

External barriers to success

Figure 2.7



Percentages indicate share of sample experiencing difficulty

Barriers and bottlenecks

Perceived barriers to success fall into three interrelating categories – first, lack of awareness about the dynamics of entrepreneurship among officials, graduate recruits and financial institutions; second, inflexibility in the national and European legal and regulatory systems; and third, broader cultural attitudes (Figure 2.7).

The surveyed firms felt that a wide gulf existed between the concerns of high-tech start-ups like their own and those of both government and bank officials. Few have personal entrepreneurial experience of any kind, and are therefore unused and unwilling to deal with the risks associated with high-tech start-ups. At the same time, little effort is made to foster entrepreneurial awareness or attitudes through training, even among those who deal directly with small and medium-sized enterprises. Government policy and schemes still appear to be oriented largely to the concerns and needs of large-scale industry, while the interests of high-tech start-ups are poorly represented by industry associations – though it was notable that only 4% of the sample themselves took any part in trade lobbying.

Skills shortages constitute a real barrier. In particular, these firms complain that too few graduates are trained to state-of-the-art standards in emerging technologies. Technical graduates are also deficient in communication, presentation, project management and even in basic business skills. On the other hand, commercial and business courses are too much oriented towards the requirements of large corporations, and graduates have little grasp of the realities of entrepreneurial start-ups. 'Corporate attitudes' are also a problem among lower-level technical or administrative staff, who often lack flexibility and commitment. Both risk-aversion and fear of corporate failure were felt by the firms to be European characteristics, possibly reinforced by punitive bankruptcy laws, which contrasted unfavourably with the 'can-do, can-fail' US environment.

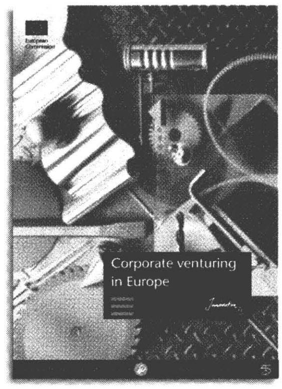
Both personal and corporate tax regimes were also seen as failing to provide sufficient incentive for entrepreneurial risk-taking. Among the tax breaks requested were a special low rate of personal taxation for the founders of companies in their first two years, and exemption from corporation tax in the first five years. Employment law also presents obstacles – in particular, limitations on working hours and the difficulty of obtaining work permits for qualified non-Europeans. Public sector bureaucracy and the high cost of patent protection were also common complaints.

chapter 3 **Innovation Finance**

Attitudes to investment in risky enterprises, especially among financial institutions, constitute one of the major cultural differences between the United States and Europe – where stability is preferred to change, and security to dynamism. To improve the access of innovative European firms to development finance, the ability of corporations, venture capitalists and banks to assess the risks and the returns of new technologies needs to be strengthened.

3.1

Corporate venturing in Europe



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Study team led by: Bannock Consulting Ltd (United Kingdom)

Neither the European Commission nor any person acting on its behalf is responsible for the use which might be made of the following information. The views in the study are those of the authors and do not necessarily reflect the policies of the European Commission.

Key Findings

- Corporate investments of €1.2 billion per year amount to 10% of total European venture capital, but 40% of **early-stage** investing. About three-quarters is invested in Europe.
- Corporate venturing is **spread evenly** through the EU's major economies, with the exception of Italy.
- **Five sectors** – communications, utilities, 'food, drink and tobacco', metal manufacturing and air transport – account for 44% of Europe's corporate venturers.
- Most corporations making a venture capital investment are primarily motivated by the **strategic goal** of forging a link with a new technology or market that might prove crucial to its future.
- Allowing entrepreneurial staff the scope to develop their ideas through **spin-outs** also gives a corporation the opportunity to exploit in-house R&D quickly and cheaply.
- Investee companies gain **credibility** from the endorsement of their investor, as well as forms of support that would otherwise be beyond their reach.
- **Taxation** levels form the main obstacle to increased corporate venturing.

Motivations

The most important motivation for a corporation to make a venture capital investment is strategic – it wants to open a window on to a new technology or market that might prove crucial to its future. Strategic reasons were weighted at 62% by the survey respondents. But it must be remembered that the financial motive of ensuring future profits underlies this. Investing in a new venture gives a corporation the opportunity to buy a new technology cheaply, develop it in partnership, or simply to stay informed of developments. CVC can also be a form of insurance – about half the money comes from companies with a degree of monopoly power, such as major pharmaceutical and privatised companies, which are also those most threatened by technological change. CVC can also be a means of spinning a non-core project out of a company.

Direct financial profit is a secondary objective of corporate venturers, with a weighting of 27%. Corporate venturers tend to invest at a premium, and opinion is divided as to how profitable CVC is, with some sources calculating the median rate of return to be as low as 7%. Others claim that it is as profitable as independent venture capitalism – that is, over 20%.

There are also human resource reasons, since allowing entrepreneurial staff the scope to develop their ideas improves job satisfaction, while also giving the corporation the opportunity to exploit in-house R&D quickly and cheaply. The exercise of social responsibility can also be a motivation for corporate venturing (6% weighting), for example through schemes to help employees facing redundancy to found their own businesses, whether these are related to the parent company or not.

The firms in which investments are made also show both financial and strategic motivations, although here the weightings are reversed – the cash (debt as well as equity) is most important, followed by technical assistance (in R&D and in manufacturing technology), help with distribution, and credibility (with financiers and suppliers). As for individual entrepreneurs, they are nowadays in a position to demand more control over their lives, and so prefer to manage their own small company than to work for a corporation.

Figure 3.1

Sector invested in:	Finance, insurance, business services	Building and Civil Engineering	Distribution, hotels, catering, repairs	Energy and Water	Chemical industry, non-energy producing materials	Metal manufacture; mechanical/ electrical/instrument engineering	Other manufacturing industries	Other services	Transport and Communication	TOTAL
Communications	3	1		3		7		1	10	25
Other Services	5	2	1	4		3	6	2		23
Transportation	5		1			4			8	18
Energy	1	1		11		1	1			15
Industrial Products and Services	4		2	1		2			1	10
Chemicals and Materials				1	2	3	1	1		8
Consumer: Other	1		2			1	3		1	8
Agriculture	1						6			7
Electronics						6	1			7
Financial Services	6					1				7
Biotechnology							2	2		4
Computer: Internet	1							1	2	4
Manufacturing	2						2			4
Medical: Pharmaceuticals					1	1	1	1		4
Construction		2								2
Medical: Healthcare					1			1		2
Medical: Instruments						1		1		2
Computer: Software						1				1
Consumer: Retail							1			1
Other							1			1

Matrix of investment area vs NACE description of investor's sector

Benefits

The corporate investor benefits by gaining access to new technologies, and maybe even a leading position in their development, more quickly and cheaply than if it tried to develop them in-house. By buying in early, it avoids paying inflated prices for quoted company shares. As a by-product, CVC opens up the company's culture.

The investee company gains credibility from the endorsement of its investor, as well as other support that would otherwise be beyond its reach. This might include access to worldwide distribution channels, research results, manufacturing technology or legal expertise as regards patent infringement. But it must avoid losing its independence or being swamped by bureaucracy.

Investment mechanisms

Corporations venture either directly, by finding and making their own investments (as did 61% of the study sample), indirectly through a venture fund (25% of the sample), or both (14%). Sometimes they even invest in the same company via both routes ('parallel investment').

They usually identify possible investments themselves, through active search procedures (for instance, by visiting universities and trade fairs), although a quarter use external advisers. But many referrals arise spontaneously through existing business contacts.

They manage their holdings in-house (40%), via a subsidiary company (15%) or informally (45%). CVC teams typically number six to eight, with investments being approved by the main board of directors. Corporations look for a high return – 25% or if possible 40% per annum – in addition to non-financial strategic benefits.

Which investments are held is commonly kept secret, for fear that it will reveal too much about the company's strategic plans or encourage unwanted applications for funding. But some companies make a virtue of inviting entrepreneurs with mutually beneficial ideas to contact them.

Investment characteristics

The sample made an average of 1.4 direct investments per year (with the largest social responsibility investors excluded). The annual spent varies from year to year, but averages €14 million per company. Sixteen companies had invested over €100 million per year for the last five years.

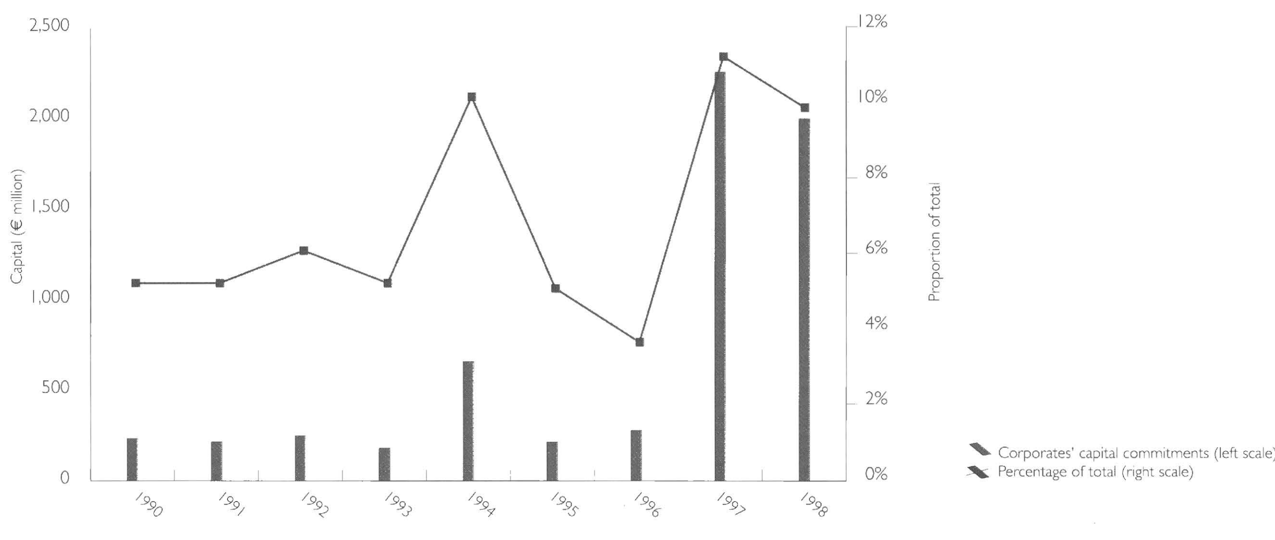
The largest single investment was €900 million, and 14 companies had invested lump sums in excess of €20 million. At the other end of the scale, over half the sample had never invested a sum larger than €5 million, and many investments were under €1 million. Start-ups accounted for 41% of investments.

Geographically, corporate venturing is spread fairly evenly through the EU's major economies, with the exception of Italy. Most investments are domestic, but some are in other parts of Europe or in North America and Asia, with a few elsewhere. Corporate venturers come from a wide range of industrial sectors, but 44% of them are in just five sectors – communications, utilities, 'food, drink and tobacco', metal manufacturing and air transport.

The destination of investments is also quite widely spread, but over half are in six sectors – services (financial, consumer and other), transport and communications, energy, biotechnology, pharmaceuticals and information technology, in that order (Figure 3.1).

Indirect corporate venturing as share of total venture capital in Europe

Figure 3.2



Investments are generally held for more than five years. Some investors have an 'all or nothing' policy, whereby they attempt to acquire 100% of successful start-ups, and dispose entirely of their interests in unsuccessful ones.

The fact that corporate venturing is not primarily about profit is borne out by the finding that about half of the sample provide non-equity finance (mezzanine debt or loan guarantees) as well as equity, and 77% also give non-financial support.

Scale and impact

The funds raised for direct corporate venturing investment in Europe are significant. At around €1.2 billion per year, they make up about 10% of total venture capital (Figure 3.2). About three-quarters of this is invested in Europe. However, they are even more significant in early-stage investing, where they make up 40% of the total. In addition to direct CVC, over €2 billion per year is being invested indirectly, that is via independent venture capital funds. By comparison, in the US direct CVC is estimated to be about five times as big as in Europe, with investment of around €5 billion per year.

The whole group of 84 direct corporate venturers had invested in 500 companies over the last five years, supporting the creation of at least 55,000 jobs. The cost to these minority shareholders alone is €120,000 per job, which is a high figure, although it will be offset by future jobs created in fast-growing start-ups. The results show with 90% confidence that companies that engage in corporate venturing also generate higher returns to shareholders. If there is a possible downside to CVC, it is that the early absorption of a challenger by a corporation may stifle competition.

Barriers

The most common reason for a corporation not to engage in CVC is an unwillingness to divert management time from core activities, linked with the feeling that it is irrelevant or not strategically useful.

The main obstacles to increased corporate venturing are levels of taxation. In particular, the rates of capital gains tax, and the complicated regimes, discourage equity investment. In some cases capital losses cannot be carried forward. Similarly, tax on share options adds to the cost of employing corporate venture executives. Other provisions, such as the taxation of hidden reserves on acquisition in some countries, inhibit cross-border activity.

The predominant opinion among those surveyed is that the best way in which governments can encourage corporate venturing is not to institute new public programmes, but to improve the overall business environment by reducing tax and regulatory barriers, and stepping up European harmonisation. There are also some indications that a clearing house would be useful in improving information flow.

Good practice

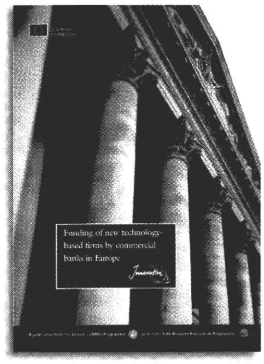
The interviews conducted in the course of the study provide additional lessons. For the best results, corporations should enter corporate venturing with clear objectives and a firm five- to seven-year commitment. They should work with independent venture capitalists, to gain expertise and to insulate venturing activities from day-to-day pressures. They should in fact treat the corporate venture unit as an entrepreneurial business within a business, appointing staff with entrepreneurial qualities rather than corporate conformists, and sharing gains with them, to deter them from leaving if they are successful.

They must recognise that large and small companies have different cultures, and must try to add value to the investee business without swamping it. In particular, they should not be excessively controlling, and should avoid favouritism by keeping post-investment commercial relationships at arm's length.

They should recognise that large corporations can no longer rely on organic growth alone, and that corporate venturing is one way of opening up their culture and helping them to change – and survive.

3.2

Funding of new technology-based firms by commercial banks in Europe



English – NB-NA-17-025-EN-C, ISBN 92-828-9731-1
Free, from the Innovation Helpdesk (see back cover)

Study team led by: Scientific Generics Limited (United Kingdom)

Neither the European Commission nor any person acting on its behalf is responsible for the use which might be made of the following information. The views in the study are those of the authors and do not necessarily reflect the policies of the European Commission.

Key Findings

- Almost all banks use the same assessment criteria for new technology-based firms (NTBFs) as for other SMEs. Specific approaches to NTBFs are more common among British banks, patchy in other parts of northern Europe, and rare in southern Europe.
- Overall, only 15% have special packages for start-up companies, and only 27% recognise the existence of an identifiable category of NTBFs.
- No bank accepts intangible assets such as intellectual property as security for a loan.
- The major barriers to increased bank lending to NTBFs are the limited flow of applications, high risk, under-capitalisation of applicants, and lack of bank expertise.
- US banks with specialist knowledge of technology markets work with venture capitalists and business angels to provide loan finance to NTBFs, even those not yet generating revenues.

Ideas are the products of individual minds, not of smooth-running corporate machines. By retaining control of their new technologies, inventors in the booming knowledge-intensive industries have a chance to prove the value of these innovations before a possible flotation or sale of the business. But to do this they need finance – and it is smaller companies, and especially those involved with unproven technologies, which face the most serious difficulties in raising finance.

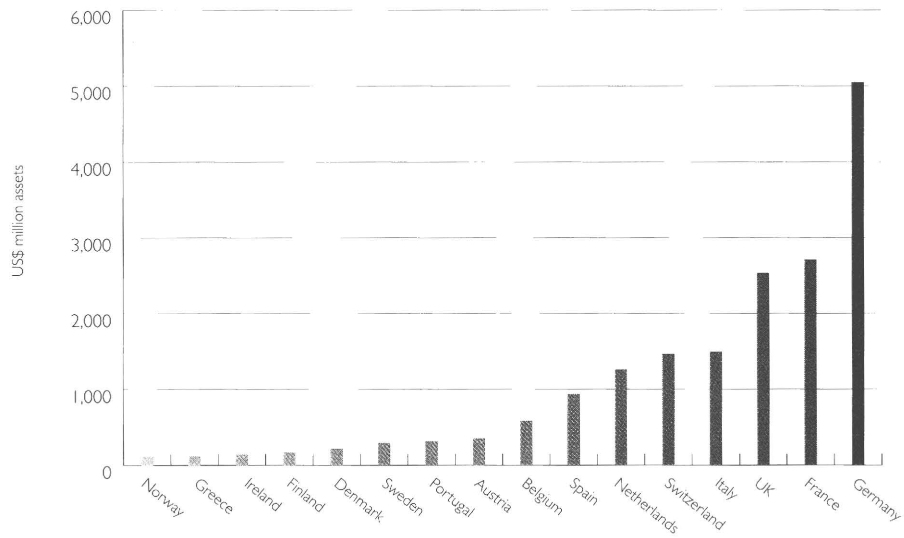
Mainstream venture capitalists prefer to make substantial investments which can more easily repay their management costs, and business angels cannot meet every demand, so small firms find it difficult to raise small sums. There is, in short, an 'equity gap', which European Union programmes such as I-TEC (see page 48) are attempting to fill. However, there may be other sources of funds that can be tapped.

This study looks not at equity but at loan finance and associated services offered by commercial banks to a particular subset of small firms – new technology-based firms or NTBFs. The classic definition of an NTBF is a firm that is less than 25 years old, is independent of larger companies, and is established to exploit inventions or innovations.

The study attempts to understand the situation from the supply side, and to codify good practice. Data were collected by interviews with 49 bank branches across Europe, and in the United States and Israel, chosen for their proximity to science parks, where one would expect to find clusters of potential NTBF customers. Expert interviews and a literature search were also conducted.

Total national commercial banking capacities, 1999

Figure 3.3



The sample of banks represents around 30% of the total assets of Europe's banks (Figure 3.3). However, as it necessarily includes both large and small banks, the percentage of capacity covered for a given country varies between 100% and 2%. As regards ownership structure, the sample includes 67% public companies, 23% co-operative and savings banks, 6% public-sector banks and 4% small private banks.

Pattern of support

The survey found a very low level of lending, and only 30% of the sample had plans to develop lending to NTBFs in the future. In general, banks liked to be seen to be serving NTBFs, but in practice treated them no differently from other SMEs – 96% use the same assessment criteria for all SMEs. Quantitative figures are impossible to compile, as most banks keep no statistics on their business with NTBFs, and those that do will not release them.

Some geographical trends can be discerned. Specific approaches to NTBFs are more common among British banks, patchy in other parts of northern Europe, and rare in southern Europe. As regards industrial sector, software is looked on relatively favourably because of its low financing requirements, and biotechnology is seen as difficult because of the long lag in revenue streams.

Bank recognition of NTBFs

The first line of enquiry concerned whether banks recognise NTBFs as a specific type of client. All the banks claimed to have products that were especially suitable for small firms, and 60% claimed these were tailored to the individual company's needs, rather than being a standard product. But only 15% had packages especially for start-up companies. These might include cheaper loans, advice and coaching, advice on grants, use of guarantees, or performance-related interest rates.

Furthermore, only 27% of the sample recognised the existence of an identifiable category of NTBFs. This appears to be a function of national policy rather than of the bank's ownership structure – three-quarters of those recognising NTBFs were from Sweden or Britain.

The level of customised service provision varies from zero up to having a specialist technology unit. Half of the banks use specialist assessment staff, who might be from universities, national laboratories, consultants or other investors such as business angels or public agencies. A further third use internal specialist expertise – experienced branch staff, head office experts, IT staff or start-up advisers.

A positive sign was that three banks (6%) had organised training seminars for branch managers on the subject of technology-based firms or young start-ups.

Products and assessment procedures

Most banks which did recognise NTBFs claimed to respond to their needs by offering a more flexible approach to security and guarantees, granting more credit (though still depending on the owner's equity), deferral of interest payments and special assessment procedures or specialist staff. On the other hand, one bank applied more stringent conditions to customers it classified as NTBFs.

The survey then looked at how banks assessed loan applications. It is interesting that some banks claimed to treat NTBFs like other clients, but nevertheless employed specific assessment procedures. Banks used five main criteria to assess loan applications:

- business plan, including cash flow
- quality and record of key personnel and management
- company track record
- security
- equity

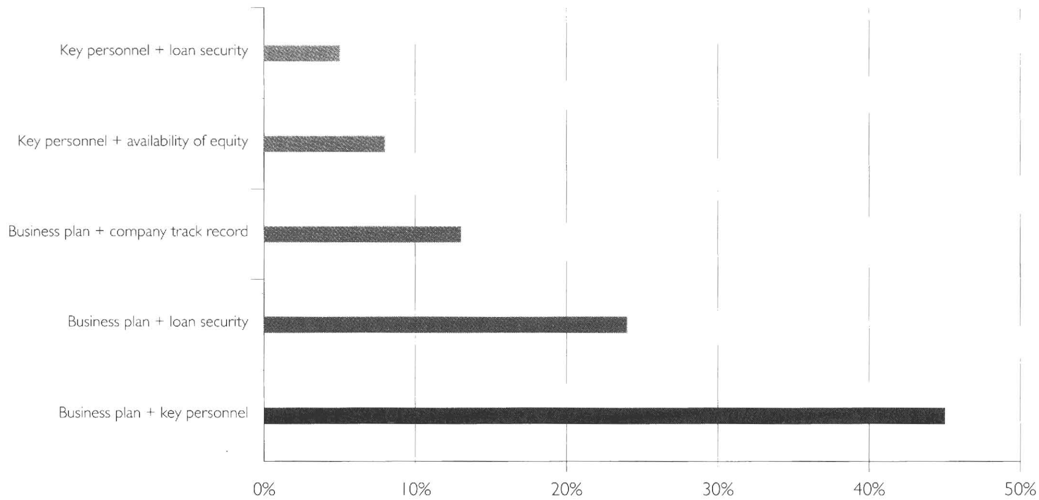
The two pairs of criteria most commonly taken into account are business plan and personnel (45%), and business plan and security (24%). Less commonly used are business plan and track record (13%), personnel and equity (8%) and personnel and security (5%). Overriding weight is therefore placed on the quality of the business proposal (41%) and of personnel and management (29%) (Figure 3.4).

Security remains a major issue, however, and the banks surveyed break into two clusters. Nordic banks (a quarter of the sample, 12 banks) differ from the rest in that they play down formal security, and invest if they have confidence in the strength of the business idea, the people implementing it, and the amount of money they themselves are risking.

A further important issue is that no bank accepts as security for a loan intangible assets such as intellectual property. This is perhaps understandable, as intellectual property, if it is to retain its value, must be understood by its acquirer. In the event that the bank had to call in the security, it would not have the skills to use it. This is not to say that the importance

Relative priority of pairs of key investment assessment criteria

Figure 3.4



of intellectual property is not recognised; as part of the overall assessment the banks insist that it be properly protected.

Barriers

The banks surveyed identified eight principal obstacles to expansion of their business with NTBFs. Four of them were major barriers, being cited between six and 13 times:

- limited supply of NTBFs applying (13)
- high risk level (9)
- limited supply of equity capital within the applicant firms (8)
- lack of expertise within the bank (6)

These barriers interact and amplify each other – so few new technology entrepreneurs come forward, in part, because there is so little risk capital available to back their ventures. The 'equity gap' thus leads to a debt gap. Similarly, banks' inexperience with NTBFs increases the risk they run. The presence of other investors would also reduce the bank's risk and increase the quality of expert appraisal.

The other four barriers were cited between one and three times:

- poor quality applications which do not give the information needed to assess risk
- lack of tangible assets to pledge as loan security
- lack of expert due-diligence services which are cost effective for these applications
- lack of publicly supported loan guarantees

It is noteworthy that cultural and regulatory barriers were not mentioned, despite prompting.

USA and Israel

Studies in the USA, where economies of scale are greater, show that a class of banks with specialist knowledge of technology markets works closely with venture capitalists and business angels to provide loan finance to NTBFs, even those not yet generating revenues. In fact, the presence of such a specialist is linked to the strength of regional technology clusters, although in the early stages they too insist on the protection of high equity cover for their loans.

Successful specialist lenders in the US tend to 'chase the smart money', that is collaborate with the best-performing venture capitalists to pick out those NTBFs with the strongest equity cover for their loans. These cash-rich firms will often, in fact, leave large amounts on deposit with the banks, only using their credit facilities during growth spurts.

Banks tend to provide loans for the purchase of equipment (typically above $300,000), to finance stocks, and to bolster working capital prior to an equity injection.

Although US banks do take a charge on all the business' assets, an interesting NTBF-friendly difference is that they will attach a value to intellectual property as part of securing a loan, as it is more easily realisable given the density of similar businesses in the locality. A further difference is that specialist banks have now started to blur the boundary between debt and equity by including a small proportion of share options in the package.

Israeli banks are also more willing than their European counterparts to lend to NTBFs, and their national headquarters typically house a small specialist team that will lend to Israeli companies floating on Nasdaq.

Good practice

A significant strand of opinion within the banks is that good practice for commercial banks is simply to avoid lending to NTBFs. This is because banks are by definition slower than their clients to understand new technologies, and are therefore in no position to assess risks accurately. Loan finance earns a relatively low return, which must be protected. Therefore, early-stage high-risk investment, such as that required for research and development or marketing expenses, should be on an equity basis.

The most appropriate time for debt finance comes later, when the company has grown to have regular revenues, tangible assets that can be given as security, and a need for working capital.

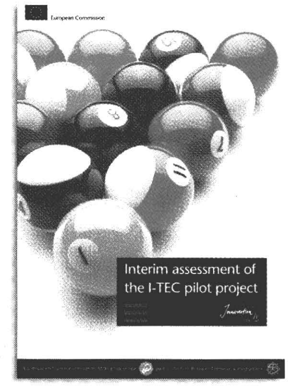
However, there may be advantages for banks in building bridges with the fast-growing high-tech sector. They might offer NTBF packages comprising cheap loans aligned with public grants. Adopting some characteristics of equity, they might link interest rates to company performance, defer interest payments, and/or take share options.

Banks can establish uniform assessment criteria which will reduce the cost of due diligence. They can tap into existing knowledge of technology markets by sponsoring university posts or consultancy services. They can train up specialist staff, and use outside experts to assess potential borrowers.

The public sector, or mutual organisations, can encourage banks to lend by offering NTBFs loan guarantees.

3.3

Interim assessment of the I-TEC pilot project



English – NB-NA-17-033-EN-C, ISBN 92-894-0634-8
€16, from Eur-OP (see inside back cover)

Study team led by: Bannock Consulting Ltd (United Kingdom)

Key Findings

- I-TEC concentrated on **building the capacity** of venture capital firms to invest in early-stage technology.
- I-TEC **complements** other schemes, uniquely supporting the cost of managing venture capital, rather than investing directly in equity or providing guarantees.
- By February 2000, I-TEC participants had committed some **€494 million** to 133 eligible companies, representing about 9% of the entire European high-tech early-stage market.
- A very high proportion of I-TEC deals were **syndicated**, indicating a trend for venture capitalists to seek reciprocal transnational syndication of investments as a way of spreading risk.
- I-TEC participants make more **cross-border investments** than venture capitalists generally.
- The industry as a whole has benefited from a long-term **increase in capacity** resulting from the engagement and training of new staff.

The I-TEC (Innovation and Technology Equity Capital) pilot project started in June 1997. Its objective is to encourage economically viable, high-quality early-stage investments in technologically innovative European SMEs. As a means to this end, it aimed to build lasting capacity within venture capital operators to appraise and manage such investments. €11 million was set aside for 28 venture capital firms – €7.5 million in I-TEC 1 and €3.5 million in I-TEC 2. An interim assessment of the pilot programme was carried out between May 1999 and March 2000.

Intervention logic

I-TEC learnt the lessons of the Seed Capital pilot action, which ran from 1989 to 1995, by concentrating on building the capacity of established venture capital firms rather than trying to encourage new ones to start up. It adopted the relatively simple method of paying half the costs of employing new investment managers, of travelling to investigate and appraise investments, and of employing outside consultants to appraise investments.

Two safeguard conditions were laid down. Reimbursement was limited to 5% of eligible investments made, and at least a quarter of the new fund had to be invested in eligible firms within three years. Funds that were already doing early-stage financing also had to invest at least 50% more than the total they had invested over the last ten years. So as to reach newly established enterprises, the SMEs benefiting from the investments had to be incorporated within the three years prior to the investment, or within the following year.

The launch of I-TEC was widely promoted, and the budget was oversubscribed. The first tranche of funding was allocated predominantly to existing venture capitalists gearing up new investment activities, and the second tranche in somewhat smaller amounts to younger firms, attempting to achieve a geographical balance across the EU.

Measures and take-up

The main measure used was a 50% contribution for three types of cost. The first of these is the employment of additional investment managers. At the time of the evaluation, 16 of the 28 participants had made use of this facility, and it accounted for 54% of all the costs claimed.

I-TEC also supported **travel costs**, particularly helpful in the early part of the cycle, as it permits staff to attend conferences and visit potential clients. It is especially useful for firms which have a proactive policy of 'making their own deals' – that is, approaching the companies they want to invest in rather than waiting to be approached. Half the companies used the travel grants, several of them (particularly new ones) found them useful. They made up 9% of costs claimed.

The third I-TEC financial measure was to support the short-term engagement of **consultants**, sometimes during the construction of the case for investment ('positive due diligence') but more often during the final checking ('negative due diligence'). Around half the firms made use of this measure, which formed 37% of the costs claimed.

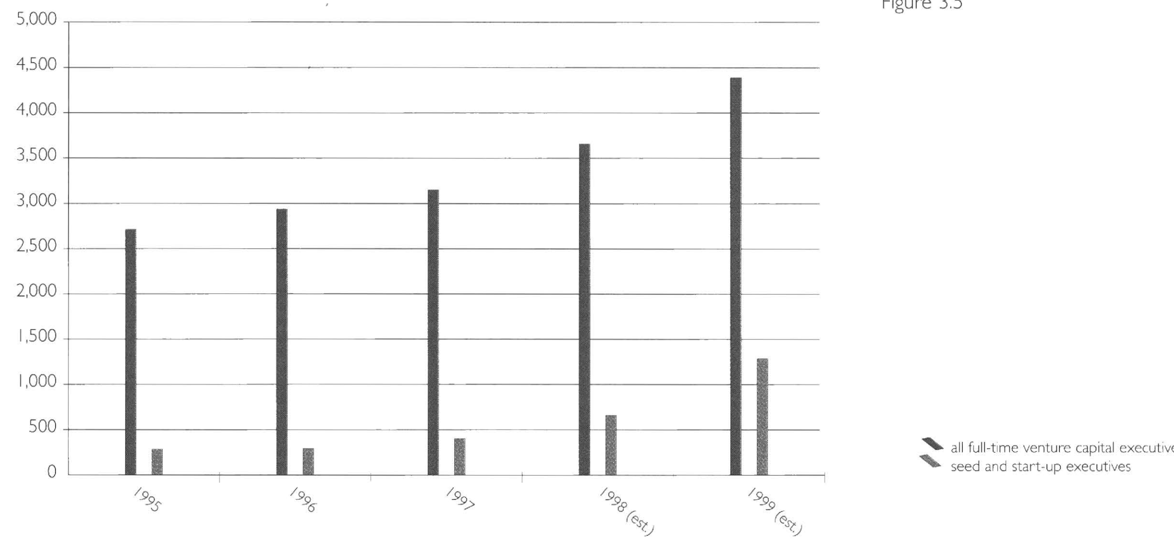
antees, supports the cost of managing venture capital.

I-TEC was operating in an increasingly healthy environment. Over its life, investment in European high-technology start-ups exploded (Figure 3.5). At its start, returns were already improving – EVCA figures show that the benchmark return of early-stage funds between 1994 and 1997 was 24.4% p.a. Demand was also high, and consequently high-tech investment tripled from €1.3 to €4 billion per annum between 1996 and 1998. About half of this was early stage. Yet at the same time the cost of launching a viable high technology business on the global market also rose, to at least €10 million. High-tech early-stage investment in Europe is booming accordingly.

• **Funds invested** – The main immediate impact on the venture capitalists is that they could process many more deals – their 'deal flow' typically doubled, and thus they could invest money more quickly. During the three years of the I-TEC

Venture capital executives in Europe, 1995-99

Figure 3.5



In addition to financial aid, I-TEC also offered participating firms access to the Eurotech Data **information** service, which on demand prepares, within two weeks, a dossier on a technology, market sector or product. Around half of the participating funds used the service, each requesting between one and nine dossiers, and they rated it very highly.

Finally, I-TEC participants were invited to a series of half-day meetings to build up a **network** of contacts, with a view for example to syndicating investments among them or exchanging experience and good practice by discussing topical subjects such as the current exit climate or valuation procedures.

Additionality and impact

I-TEC was broadly complementary to other European and Member State schemes, such as the ETF Startup Facility[1] and LIFT[2]. Of the 182 national schemes in support of innovation listed in the database of the *European Trend Chart on Innovation* (see page 26), 43 (23%) concern finance. I-TEC differs from most of these in that it targets entrepreneurs not directly but through venture capitalists. It is the only scheme in Europe that instead of investing directly in equity or providing guar-

project, participants committed some €494 million to eligible companies, which represents about 9% of the entire high-tech early-stage market. The average size of the investments is €610,000 – slightly smaller than European seed and start-up investments in general.

• **Transnationality** – I-TEC participants are more transnationally minded than venture capitalists in general, and one-sixth of the eligible investments are cross-border.

• **Syndication** – Half the I-TEC deals were syndicated, which is twice as many as the norm. This appears to indicate a trend whereby venture capitalists are strengthening their European links and seeking reciprocal syndication of investments as a way of spreading their risk.

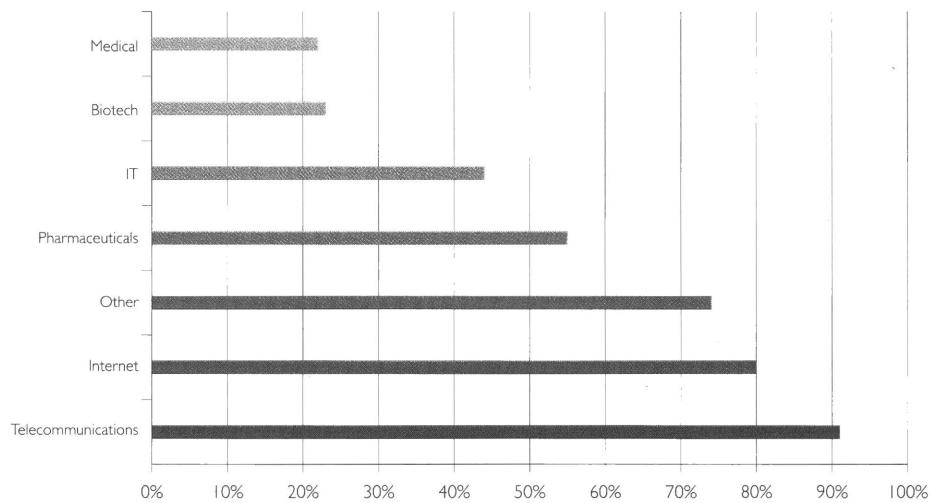
• **Staff** – The industry as a whole has benefited from a long-term increase in capacity resulting from the engagement and training of new staff. I-TEC has supported the engagement of some 30 new investment managers directly, predominantly below 35 years old, who constitute new talent coming into the venture capital industry.

• **Investee companies** – As at February 2000, I-TEC participants had reported 133 eligible investments. Two-thirds of them are in the internet, telecom and IT sectors and a further

(1) The European Technology Facility Startup Facility (ETF Startup Facility) is part of the European Commission's Growth & Employment Initiative.
(2) LIFT (Linking Innovation Finance and Technology) is an action of the Innovation and SMEs programme of the EU's Fifth Research Framework Programme. It is available at http://www.lift.lu/

Estimated annual employment growth in portfolio companies, 2000-01, by sector

Figure 3.6



quarter in pharmaceuticals, medical and biotech. Two-thirds of them are small companies with less than ten employees. There is a broad geographical distribution.

- **Employment** – Working from investee companies' own projections, it can be estimated that by the end of 2001, the number of people employed in the average I-TEC-supported company will have risen from 21 to 59. It is reasonable to assume an average investment of €45,000 per job over the life of the investment, implying creation of around 11,000 jobs associated with the total investment of €494 million. It is important to remember that some companies will not grow as predicted, that not all these jobs will be new, and that there will be incalculable displacement effects. Employment is expected to grow fastest in the telecommunications and internet sectors, and most slowly in medicine and biotech (Figure 3.6).

Barriers and prospects

Some design factors reduced the efficiency of the pilot project. First, the rigid administrative requirements of the Fourth Research Framework Programme made for high compliance costs. Secondly, there was uncertainty over what costs would be reimbursed. A further brake on an effective use of the budget was that amounts granted to but not claimable by one company could not be redirected. But the greatest barrier was the three-year age limit on beneficiary SMEs – in biotechnology in particular, new products may take longer than three years to gestate.

I-TEC appears to have nursed into existence a pattern of collaborative cross-border investment in small innovative companies. Meanwhile, the demand for early stage investment continues to outstrip the supply of skilled labour available to manage it.

There is a good case for a successor programme of grant aid to be launched, but with a redesigned selection procedure, and with amended eligibility conditions to improve targeting and additionality. A simpler system of a flat-rate grant per new staff member employed might prove considerably cheaper to operate.

The information, networking and professional development aspects of I-TEC are worthwhile and could continue on a stand-alone basis.

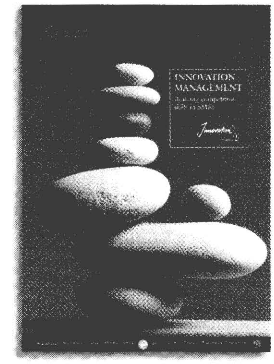
chapter 4 **Innovation Management**

4

Small and medium-sized enterprises (SMEs) are widely viewed as key sources of future European competitiveness and employment. In high-tech sectors, rapid growth can transform today's start-up into tomorrow's global market leader, and even traditional manufacturing firms have the potential to grow by absorbing new technologies developed by others. However, Europe's SMEs remain poorly equipped to fulfil this potential, with limited capacity to manage innovation and change, and to defend their intellectual property.

4.1

Innovation Management: Building competitive skills in SMEs



English – CD-17-98-160-EN-C, ISBN 92-828-4650-4
€16, from Eur-Op (see inside back cover)

Study team led by: SOCINTEC S.A. (Spain)

Neither the European Commission nor any person acting on its behalf is responsible for the use which might be made of the following information. The views in the study are those of the authors and do not necessarily reflect the policies of the European Commission.

Key Findings

- Innovation is less a question of technology than a **way of thinking** and of viewing the enterprise and its surroundings.
- **SMEs** have been slow to adopt the innovation management techniques (IMTs) now widely used by their larger competitors to support the innovation process.
- This report identifies ten types of IMT which are particularly suitable for use by SMEs, have a proven track record, focus on improving **competitiveness**, and require no more than ten days of consultancy time.
- The benefits of IMTs are greatest when they are seen as serving the **strategic goals** of the company, rather than as one-off fixes for specific problems.

Why do small and medium-sized enterprises (SMEs) need to innovate? The answers are familiar by now – technical progress makes their products obsolete, globalisation exposes them to new competitors from distant parts of the world, rapidly changing markets require more responsive production processes, and more demanding customers call for higher quality and better services. Standing still is no longer an option. As the European Commission's 1995 Green Paper on Innovation said: "Innovation is at the heart of the spirit of enterprise and thus companies must constantly innovate, even if only gradually."

Being aware of the need to innovate is one thing, but knowing how to do it is something else. What do you actually do? How do you start? Who can help?

Innovation Management: Building competitive skills in SMEs is based on experience gained from the Innovation programme of the European Union's Fourth Research Framework Programme (FP4). It offers a practical guide not just for SMEs, but for innovation agencies, technology institutes, Innovation Relay Centres, consultants and other bodies concerned with innovation.

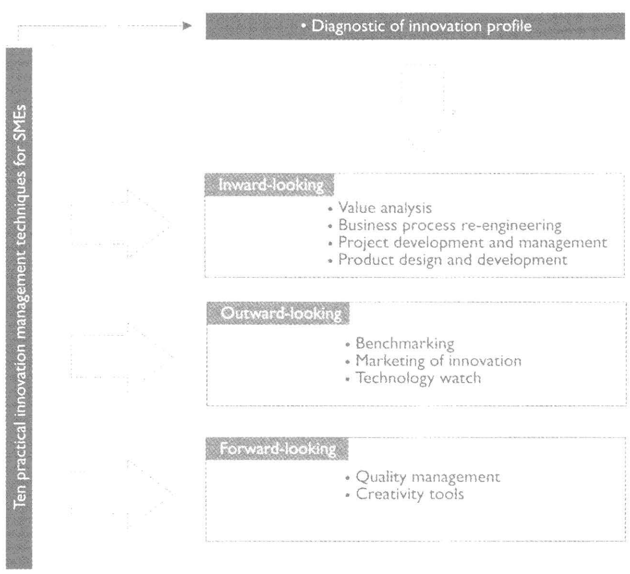
The first point to understand is that innovation does not always mean employing the very latest in unfamiliar, expensive, cutting-edge technology. On the contrary, innovation is less a question of technology than a way of thinking and of viewing the enterprise and its surroundings. While technological advances may be the result of such thinking they are not themselves enough to secure a company's future. The many cases of successful innovation in traditional, mature industries tend not to make headlines, but all companies need to innovate because they all need to survive.

Indeed, too much focus on technology can distract attention. It has been estimated that 90-95% of all attempts to launch technologically innovative products end in failure. One reason is that companies think they are developing a product when in reality they are making a 'technical object' – a bright idea – which may be excellent in its own way but does not necessarily meet the needs of the market. Innovation does not just mean new ideas, it means new ideas that sell.

Large companies have long been aware of the changes in their markets and many have responded to the need to manage innovation. They have examined themselves and in doing so have created a range of tools and techniques to help them adapt to changed circumstances and meet new market challenges. They learned the hard way – those that did not are no longer with us. SMEs, on the other hand, have been rather slow to adopt the measures now widely used by

Ten selected Innovation Management Techniques

Figure 4.1



their larger competitors to support the innovation process. This is both paradoxical and worrying, since it is widely held that their flexibility and nimbleness give SMEs far greater potential for rapid innovation. Much of EU and regional innovation policy is now focused on nurturing SMEs, and great expectations are riding upon them.

So what is the problem? It is certainly not that SMEs are unaware of the need for innovation. But for a small company, planning what to do and how to do it can be daunting. Big companies may have the resources to set up whole teams devoted to innovation but SMEs do not. They depend on others to help them. But what kind of help do they need? How do they become more innovative? How much will it cost? Who can they turn to and who can they trust?

Innovation management techniques

Over the years, large companies have created a series of methodologies called innovation management techniques (IMTs) to address the problems of innovation in a systematic way. For the most part, however, SMEs know little of these techniques, yet many IMTs represent a distillation of corporate experience and wisdom which is readily adaptable to the circumstances of small companies. One aim of FP4's Innovation programme was to support the pilot application of selected techniques by SMEs themselves.

This report identifies ten types of IMT which have been judged particularly suitable for use by SMEs (Figure 4.1). They all have a proven track record, focus on improving competitiveness, require no more than ten days of consultancy time and have been widely used in 24 projects in the Innovation programme's 'Promotion of Innovation Management Techniques' action line.

Every company is advised to begin with a **diagnostic of innovation profile**, which helps identify its innovation strengths and weaknesses. It may take from five to 20 days, including visits, interviews and analysis – and usually examines 12 aspects of the company's work. The object is to a draw up an action plan which may involve using one or more of the other IMTs.

Four IMTs are grouped as 'inward looking' since they help the company examine its 'metabolism' with the aim of improving its internal functioning. The first, **value analysis**, is a technique for finding out how to obtain the maximum value from a product, process or service. In this case 'value' is the customer's perceived value of the product or service judged by how useful it is and how much the customer is prepared to pay. The analysis can lead directly to the identification of new products and services.

More radical is **business process re-engineering**, which essentially rebuilds the company from scratch to achieve radical improvements in time, costs and quality. The fundamental concept behind re-engineering is not merely to reorganise the company's structure into a new one of greater or lesser complexity, but to transform its processes. **Project development and management** is a set of tools intended to help the company to organise itself better to carry out specific projects. It includes such well-known methods as critical path analysis and programme evaluation and review technique (PERT). This is related to **product design and development**, a broad set of techniques to assist the actual design and manufacture of a new product. Many possibilities are discussed here, including several to aid product design (such as concurrent engineering and failure mode and effects analysis) and others to assist with computation (finite element analysis, rapid prototyping, and so on).

A further group of three IMTs is described as 'outward looking' since they seek to examine the company's relationships with its competitors and with the market. Perhaps the most familiar is benchmarking, which is the process of comparing aspects of the company's performance with the best in the sector. The areas most commonly **benchmarked** include costs, products, customer service, productivity, innovation and use of resources. The idea is to understand why differences exist and to plan how to reduce them. **Marketing of innovation** is a relatively new tool to ensure that a product is not just a 'technical object' but really is a marketable product meeting customers' needs. This technique is most effective when the product is still in the design phase and is particularly valuable for radical innovations. **Technology watch** is a way of systematically keeping track of developments in the market to ensure that the company can move swiftly to exploit new opportunities. An important element of this is being aware of the patents filed in the firm's field of interest, both to avoid potential conflicts with existing patents and also as a source of information for benchmarking.

Finally, there are two 'forward-looking' IMTs which deal with the company's capacity to manage change. **Total quality management**, one of several techniques originating in Japan, ensures that product quality is built in from the start and is well known for requiring the commitment of all the employees in a company. All these IMTs require new thinking and several **creativity tools**, from brainstorming to lateral thinking, are presented to get employees thinking in new directions.

There is a full list of references for further reading and an appendix of descriptions of each of the 24 projects in the Innovation programme in which these ten IMTs were applied.

It would be misleading to think of these IMTs as a medicine-chest of remedies which can be dispensed according to whatever corporate ailment has been diagnosed. There is no simple one-to-one correspondence between the problem and the solution. Every company is unique, more than one IMT is usually required, and the techniques themselves must be tailored to the needs of the individual company. Even more important, the benefits of applying IMTs are greatest when they are seen as serving the strategic goals of the company, rather than as one-off fixes for specific problems.

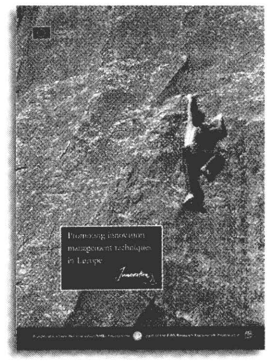
A supportive environment

Although the report is presented somewhat like a cookery book, SMEs are not expected simply to pick out the recipes that appeal to them and start cooking. Success in innovation depends critically on the environment in which the company operates – the 'climate of innovation' – and this varies greatly from region to region. Few SMEs have access to a ready-made 'innovation network' linking companies with universities, technology centres, innovation agencies, local and national government, trade associations, foundations, consultants and financial institutions.

A second crucial success factor is the number and diversity of consulting firms that can support SMEs and act as the interface to the support network. Indeed, while a few SMEs may be able to use one or more of the IMTs without external assistance, it is much better for them to employ an experienced consultant to guide them through the process. This does not mean that the consultant should do all the work – active engagement by the company is essential in all these techniques. But a consultant is not blinkered by the established wisdom of a company's management team, and can take a more objective view of its problems. This appears to help the company to learn from the experience and to take action. National and regional innovation agencies, in turn, have an important role in supervising the consultants and creating an atmosphere of optimism and trust.

The real challenge is to equip SMEs to 'feel' the innovative environment – to sense change and to believe that they can be part of it.

4.2



Promoting innovation management techniques in Europe

English – NB-NA-17-022-EN-C, ISBN 92-828-9688-9
Free, from the Innovation Helpdesk (see back cover)

Study team led by: Erdyn Consultants S.A. (France)

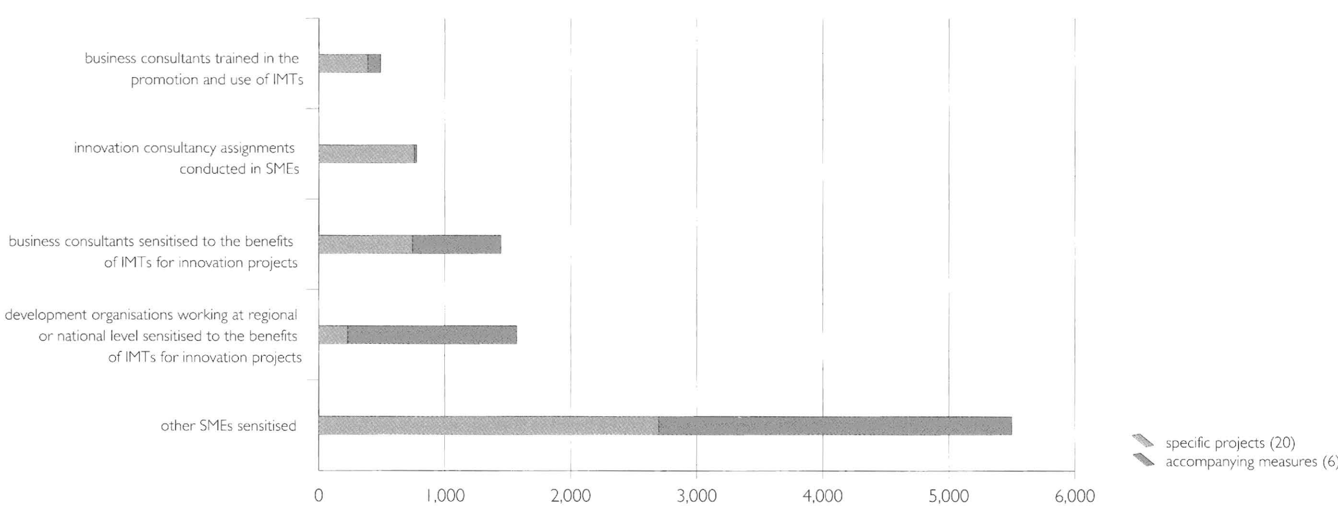
Key Findings

- Twenty-three projects, involving **800 SMEs** in the European Union, enabled 90 business support organisations to improve their expertise in designing and managing Innovation Management Technique (IMT) promotions, to train consultants and to test the methodologies with SMEs.
- Most projects were **national or regional** in scope.
- Two-thirds of the participating business support organisations are **continuing to use** the IMTs developed in the projects.
- The projects had **difficulty in targeting** SMEs whose needs were well matched to the IMTs on offer. IMTs are ineffective in SMEs which lack a strong existing management culture.

The first report featured in this chapter describes ten types of Innovation Management Techniques (IMTs) applied within SMEs as part of the Innovation programme. By contrast, this report assesses the success of that action line, 'Promotion of Innovation Management Techniques', which ran from 1997 to 1999. It involved 23 specific projects and six accompanying measures (Figure 4.2). A total of 90 organisations took part in the 15 EU Member States and Norway, Iceland and Israel. The aim was to sensitise SMEs, consultants and business development organisations to the potential of IMTs.

Estimated overall results in 15 EU countries

Figure 4.2



Using IMTs with SMEs

The first part of the action line consisted of a series of specific projects designed to strengthen the know-how of the national and regional organisations that promote IMTs for SMEs. The 23 projects (including one double project) were chosen so that the partner organisations could improve their expertise in designing and managing IMT promotions, to train consultants and to test the methodologies with SMEs. Most projects were national or regional in scope. At the heart of each were a number of consultancy assignments with individual SMEs, in which the IMTs could be evaluated in a real business setting. Four hundred consultants were trained to ensure that they would use the IMTs being promoted in the project.

The SMEs themselves, some 760 in the EU countries alone, were mainly well-established firms already interested in introducing new products or ways of working. Fifteen per cent of them employed one to ten people, 53% 11 to 50 and 32% 51 to 500 people. Most were already known to the participants in the projects, and while this helped ensure a successful outcome it did limit the potential of each project to spread awareness among the local SME community.

Each assignment took the form of an initial diagnosis and recommendations, followed by a specific analysis using IMTs and leading to an action plan. The assignment concluded by monitoring and supporting the implementation of the plan over a six-month period. EC funding allowed for up to ten days' consultancy time, though a few contractors were able to obtain regional or national funding to extend the assignments. All the contractors organised promotional events including workshops with representatives from businesses, institutions and consultants, training seminars with company managers and contributions to conferences on innovation and technology transfer.

So what were the benefits to the various parties (Figure 4.3)? There was a broad consensus among all the participants that promoting the use of IMTs among SMEs was useful, especially for those which already have a technology development strategy as well as the human and financial capacities to carry out innovative projects. Due to the sheer number of SMEs in Europe, such promotion is best carried out at a regional level.

The IMT contractors, the agencies and institutions who were direct participants in the projects gained experience in co-ordinating the work of consultants in several IMTs and in setting up schemes for their skills to be made available to SMEs. Eighty per cent of them said they could not have undertaken such work without EC support, and wished to continue to develop the schemes with regional or national funding. On the other hand, similar bodies who were not involved in the projects expressed little interest.

The EC's practice of supporting projects on a shared-cost basis seems to have deterred many private organisations from taking part in this action line. While the principle is appropriate for conventional research projects promising a return in exploitable know-how for the participants, it promises no such return for organisations engaged in promotional activities. The few private contractors who did take part (4%) were already accustomed to working for the public sector.

Four-fifths of the consultants found the intervention methods interesting and useful. But while 65% are continuing to use the IMTs developed in the projects, only half felt that they had been kept sufficiently informed about the other projects in the action line. They would like to have learned more about a wider range of techniques.

The response of SMEs to the authors' survey was very poor but those who replied were satisfied with the progress made while working with the consultants, though it seems that in only half the cases were the benefits directly linked to innovation. This suggests that the projects had difficulty in targeting SMEs whose needs were well matched to the IMTs on offer. One contractor pointed out that IMTs cannot be effective in SMEs that do not already have a good management culture.

Spreading know-how

The second part of the action line was rather different. It consisted of six accompanying measures designed to support the exchange of know-how and good practice between innovation agencies in different countries – up to ten countries in each case. Three of these projects looked at industrial design, one studied technology watch, and another examined management techniques applicable to innovation. The sixth made a comparison of IMT promotion practices.

Although these projects allowed the participants to master the IMTs and learn how to use them, the impact of the promotional activities was limited to those organisations which played a direct part in the projects. The impact on the wider innovation community was only slight, and little impact was made on the specific projects themselves.

There were a number of reasons for this limited success. First, the specific projects were constrained by their contracts with the European Commission, which allowed little room to revise their workplans in the light of new experience. Second, the results of the specific projects became known only when they had finished, at a time when the accompanying measures themselves were also coming to an end. It is likely that the true benefit of the exchange of experience would only have been realised in future projects.

The authors also point out that the organisations involved in the evaluation projects were led by practitioners whose interests lay in meeting the concrete needs of business rather than in engaging in academic comparisons of promotional methods. Seminars focused on descriptions of the projects themselves rather than on methodological comparisons, and a website set up to allow participants to compare their working methods was hardly used.

Nevertheless, nearly all the organisations that took part in the action line said they were satisfied with what they had achieved, especially the tools and training programmes that they had developed.

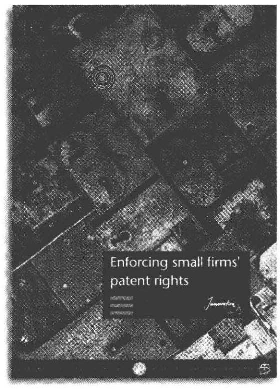
Means of promotion	*Impact on SMEs*	*Impact on Development Organisations*	*Impact on Consultants*
IMT training seminars	++	++	++
Application case study publication	-/+	++	++
Meetings including IMT-user testimony	++	-/+	-/+
Technical assistance in implementing IMT	++	--	--
Consultant diagnosis of enterprise IMT needs	++	--	--
Enterprise sensitisation by specialist visits	++	--	--
Drafting of promotional flyers and pamphlets	-/+	-/+	-/+
Publication of practical IMT-use guides	-/+	-/+	-/+
Press articles (newspapers and magazines)	-/+	-/+	-/+
Internet web site development	--	--	--
Production of CD-ROM describing IMT use	--	--	--
Radio and television programmes	--	--	--

Figure 4.3

Impact of various means of IMT promotion
(mean grade out of 10):

++ (strong): mean grade > 6
-/+ (medium): mean grade between 4 and 6
-- (weak): mean grade < 4

Enforcing small firms' patent rights



English – NB-NA-17-032-EN-C, ISBN 92-894-0633-X
€17.50, from Eur-Op (see inside back cover).

Study team led by: University of Dublin (Ireland)

Key Findings

- Two-thirds of the sample firms had experienced attempts to copy their patented inventions, but only one in five actually used the courts to defend their patents.
- For 49%, fear of the cost of patent-defence litigation had a 'very big' or a 'significant' impact on their investment in invention.
- The current patent system works poorly for SMEs. Especially in the US, large firms use the resources which they have available for litigation to intimidate SMEs.
- For SMEs, patenting is currently not cost-effective as a means of protecting intellectual property.
- Only in very rare cases are penalties for infringement awarded in practice.
- Compulsory expert arbitration should be investigated as a solution to the excessive costs of patent litigation.

For many years there has been concern that patents are under-used by small and medium-sized enterprises (SMEs), which therefore rely disproportionately on secrecy and speed to market, rather than on patents, to protect their inventions. Also, they do not fully exploit patent information as a source of technological and market intelligence. Efforts to improve SMEs' access to patent protection have focused on reducing the costs of obtaining and maintaining patent grants. But since a patent is no more than 'a licence to litigate,' the real issue is the cost of enforcing the rights it purports to grant, which can be far too high for SMEs in terms of both time and money. Anecdotal evidence has suggested that even those SMEs which owned patent rights were often failing to defend them. Two causes of this failure were assumed to be the difficulty of monitoring whether infringement was taking place, and fear of the cost of litigation to assert patent rights if it was.

Enforcing small firms' patent rights sets out to measure empirically SMEs' ability to monitor infringement of their patents, and their experiences of litigation. Its conclusions are based on questionnaires completed by over 600 SMEs, drawn from every EU Member State, which had obtained a European or United States patent between 1994 and 1997, and on interviews with the majority of these respondents.

Survey findings

- Almost every firm had made and tested a prototype of at least one of its patented inventions. In 63% of cases, the product was subsequently manufactured and put on the market by the firm itself, in 22% by the firm and one or more licencees, and in 6% through licensing alone.
- Sixty-seven per cent of the firms reported that there had been attempts to copy their patented inventions, but only 24% had experienced difficulty in learning about this.
- In 26% of cases of infringement, the copying was done by firms larger than the patent holder, and in 34% by a company of approximately the same size as itself – 11% reported that their invention had been copied by firms in both size categories.

- The financial impact of infringement was considered to be 'unimportant' or 'bearable' by 46% of the firms, but for 21% it was 'very serious'.
- Only one in five SME patent holders actually used the courts to defend their patents – 15% began legal proceedings but abandoned them, presumably without any concession from the infringer, 23% got a settlement of their case before it reached the court, 21% went as far as trial and half of these (11%) to appeal. Technical arbitration was used to settle the dispute in only 9% of cases.
- Fourteen per cent of the responding firms had taken out insurance against the cost of patent litigation, but only 2% had made a successful claim. Over half doubted whether such insurance would deter potential infringers, and only 5% were sure that it would.
- In 40% of cases, fear of the cost of patent-defence litigation had no impact on investment in invention. However, for 13% the impact was 'very big', and for 36% it was 'significant'.

Conclusions

The study amply confirms fears that the current patent system works poorly for SMEs. It provides strong evidence that large firms use the resources which they have available for litigation to intimidate SMEs. This pattern is most pronounced in the United States, where it is reinforced by the built-in bias against foreign and other non-local patentees of the District Court jury system for patent cases – and amounts to serious protectionism against non-US high-tech firms, even if this is inadvertent on the part of the authorities.

Although a few firms do obtain some compensation from infringers, in general it appears that for SMEs patenting is currently not a cost-effective means of protecting intellectual property. Infringers are unlikely to be deterred by efforts to highlight the penalties for infringement, since it is only in very rare cases that such penalties are awarded in practice. On the other hand, however, publicity of this kind would be an important element of co-operative protection arrangements proposed on the basis of the study's research.

The EU's 1999 ETAN(1) expert report on Strategic Dimensions of Intellectual Property Rights recommended that compulsory expert arbitration should be investigated as a solution to the excessive costs of patent litigation. More recently, a Working Group of the European Patent Organisation recommended that EU governments should follow the US lead and introduce legislation to make the arbitration of patent disputes easier.

The study presents empirical evidence supporting these recommendations. Secondly, until the necessary legislation is in place, it recommends the establishment of an EU-wide voluntary grouping of SME patentees – a so-called 'Patent Defence Union' (PDU) – to defend their patents. Members of the PDU would agree to technical arbitration of any dispute with another member, which the data collected by the study suggests could deal with around a third of all cases. Of the firms approached, 52% said that they would join the proposed monitoring organisation if it existed now, and an additional 9% said that they might.

The PDU would not be an insurance scheme, since it would offer no guarantee to any individual patentee that his litigation costs would be met. But it would fight as many cases as its resources allowed, with the aim of ending the intimidation which makes so many SMEs' patents effectively worthless.

The study suggests that to achieve viability the PDU would need a subscription base of approximately €1 million per year, paid in respect of 10% of the 18,000 SME patents requiring protection. To launch the PDU, one-off funding could most appropriately be provided by diverting a tiny part of the annual subsidy of €170 million currently received by the National Patent Offices from renewal fees on European patents. Some of this subsidy is already used to promote the use of patents by smaller firms. However, diverting less than 1% of the National Patent Offices' subsidy to the PDU, enabling it to operate at its break-even level from the start, would do much to strengthen the ability of these smaller firms to enforce the patents which they obtain.

The Patent Defence Union might be governed by a Council composed of representatives of the many groupings which promote the interests of smaller businesses and inventors throughout the Member States. The strongest candidate for its location is Denmark, since the authorities in that country have for many years been most active in pursuing the cause of the defence of SME patents.

(1) The European Technology Assessment Network, at http://www.cordis.lu/etan/home.html

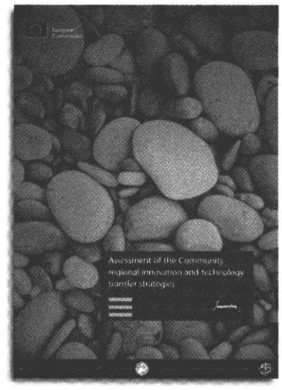
chapter 5 **Regional Issues and Approaches**

5

The pace and mechanisms of economic development vary widely across the EU and within Member States. As a result, there is wide consensus that innovation policy should be framed at the regional level – not only to take account of local economic circumstances, but also to be closer to SMEs, which are regarded as the primary engines of innovation and growth, and therefore as key 'clients' of the economic development process.

5.1

Assessment of the Community regional innovation and technology transfer strategies



English – NB-NA-17-028-EN-C, ISBN 92-894-0629-1
Free, from the Innovation Helpdesk (see back cover)

Study team led by: University of Newcastle (United Kingdom)

Neither the European Commission nor any person acting on its behalf is responsible for the use which might be made of the following information. The views in the study are those of the authors and do not necessarily reflect the policies of the European Commission.

Key Findings

- The RITTS process supported the development of politically endorsed regional **technology transfer and innovation strategies,** based on dialogue between all stakeholder groups.
- RITTS projects led to **adaptation and improvement** of existing regional innovation support infrastructures and the design of new measures in response to demand.
- The benchmarking of regions' policy and support instruments stimulated **inter-regional learning.**
- **Steering committees** of representatives from major public sector agencies and universities provided oversight of strategy development and implementation, and secured political support and legitimacy.
- Business was found to be most effectively represented by bodies such as **chambers of commerce** and industry associations.
- In regions where a strong innovation network does not already exist, the steering committee may need to be reborn as a permanent **'innovation forum'.**

The Regional Innovation and Technology Transfer Strategies and Infrastructures (RITTS) programme was launched in 1994 under the Innovation programme, now managed by the Directorate-General for Enterprise. Its aim was to help policy-makers and regional development organisations assess the technology transfer support structures in their regions, and to develop strategies and implement actions to improve the quality of the match between the services supported by regional funding agencies and the needs of the region's firms, especially SMEs (Figure 5.1).

The way in which this assistance was supplied added a transnational European dimension. RITTS provided funding for regions to engage consultants drawn from an international team of experts approved by the Commission. The idea was to encourage best practice by taking advantage of experience gained in other European regions. Regions would therefore have access to high-level international expertise and be able to evaluate their performance against international benchmarking standards. An EU-funded network would provide information, facilitate personal contacts, organise conferences and workshops, and collect and diffuse practical experience.

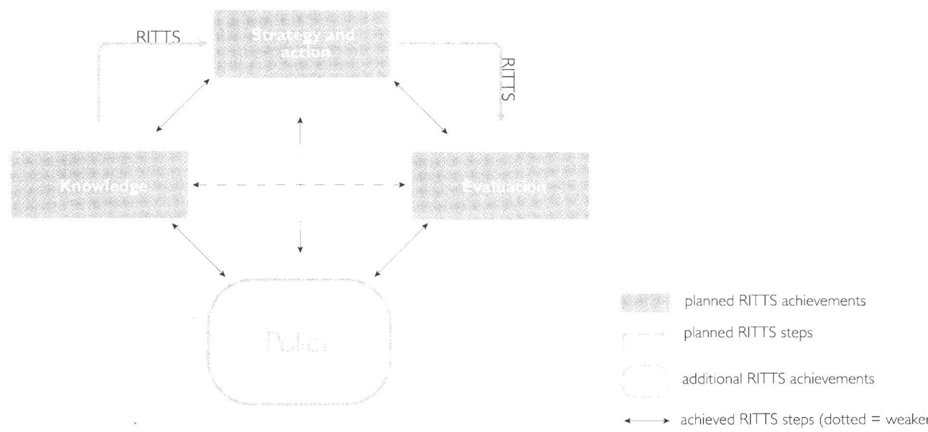
Three principles guided the projects. First, they should be 'demand-led', providing innovation support of kinds actually needed by SMEs. Second, the exercise placed stress on building a consensus within the region for the priorities to be addressed. This required as many regional stakeholders as possible to be brought in at an early stage. Third, although the analysis and planning was important, RITTS was mainly about taking practical action to bridge the gap between the supply of innovation services and the demand for them among SMEs.

Each project had three phases – examination of the existing infrastructure, proposals for improving the infrastructure, and implementation and monitoring of the priority actions. A fourth was added later to ensure that adequate organisation, funding and planning was in place from the outset.

The RITTS scheme was open to all EU regions, plus Iceland and Norway. Unlike many EU programmes, proposals were not restricted to areas already receiving other regional assis-

Types of achievements of the RITTS programme

Figure 5.1



tance. The 42 regions chosen in the first two calls for proposals, in 1994 and 1996, were highly diverse, including some with booming economies and others which were in industrial decline. Geographically, they ranged from North Sweden and Iceland to the Canaries and Crete. Some regions were well-established administrative divisions (including two nation states) and others were ad hoc regions put together for the RITTS proposals. What they all had in common was a desire to improve their support for industrial innovation, whether in high-technology firms or in the more traditional sectors.

Good project management

Clear and realistic aims and objectives turned out to be critical to the success of the projects. Only a few regions started out with a clear rationale but others developed it as their project unfolded. Some found that their plans were too ambitious. Those without clear aims seemed to view the project as little more than a study and hoped that the consultants would offer ideas for them to follow.

Those with clear objectives had considered such questions as: Why are we bidding for this project? What do we want to achieve? What do we already know about innovation in the region? What do we need to find out? How will we achieve our goals and what will it cost? What can we do ourselves? What help do we need from the consultants and from other regions? Advice on project management was provided by the Commission. Each region had a project co-ordinator working with a small team to manage the day-to-day co-ordination of the project, while a broadly-based steering committee oversaw its strategic direction.

The steering committee typically included representatives from the major public sector agencies and universities in the region. As well as providing oversight of strategy development and implementation, this ensured that the project had political support and legitimacy. A survey of participants showed that the committees' most important roles were to build consensus around the diagnosis of the problems and the strategic response to be followed. "It becomes clear, then, that members of the steering committees primarily see their roles as focused on debate, advice and political legitimacy rather than a more action-oriented approach in fund-raising, identifying projects, implementation or providing expertise." Some regions found it difficult to retain the interest of private sector partners, and business was found to be more effectively represented by bodies such as chambers of commerce and industry associations.

Most regions also set up working groups to assist consultants in the development of strategies. Once again, having respected people from key agencies in the working groups helped to build consensus and to secure acceptance of their proposals.

It is also important to plan for the future and consider what will happen to the RITTS structures when the project comes to an end. Where a strong innovation network already exists, the functions of the RITTS project may pass seamlessly to existing bodies, but in other regions the steering committee may need to be reborn as a permanent 'innovation forum', for example.

International consultants, local expertise

International consultants played an important role in RITTS projects. They studied the supply and demand for innovation support services in the region and provided expertise on formulating strategies. Most of the time their work was seen as positive and of central importance to the success of the projects. They were valued for their independence, specialist knowledge, external perspective, benchmarking skills and new ideas brought from other regions.

The benefits brought by the consultants included examples of good practice, models of innovation, skills in running RITTS-type projects, independence and an external perspective strong enough to confront local bodies with sometimes unwelcome truths. A key benefit was the set of analytical tools and techniques which could be applied to the problems of the region. Where the contribution of consultants was disappointing, this was attributable to problems such as poor data collection, inappropriate methodologies, limited engagement, poor local knowledge, language difficulties, arrogance, inadequate briefing and management, or simply having too many consultants.

On the whole, the more successful regions used consultants to guide and facilitate, rather than handing over their projects to them. The most successful RITTS projects combined careful use of external consultants with the knowledge and research capacities of local consultants and organisations such as universities and employers' bodies. Regions were able to do this because they knew what they wanted the project to achieve and had effective managers in place to steer and support the consultants.

Methodological development

Perhaps the weakest part of the projects was the assessment of demand for innovation services among SMEs. The obvious method of gauging this demand – sending questionnaires to SMEs – was used widely but with a disappointing response rate. Very small firms are renowned for not taking part in postal surveys. In some cases the questionnaires were augmented by telephone surveys, but in many cases the sample sizes were still too small to be meaningful.

Interviews and focus groups were more productive, though there was a problem choosing a representative sample of firms to approach. The most common problems identified were lack of finance for innovation and lack of skilled staff (Figure 5.2).

There was a clear weakness in the absence of formal methods of demand analysis — often consultants were expected to supply the results rather than putting systems in place for the regions to monitor and understand demand for themselves. Few regions were left with detailed methodologies for demand analysis.

Analysis of supply was more straightforward, with consultants interviewing support organisations. The two most common problems identified were firms' limited knowledge of the available support services and consequent underuse of them, and fragmentation and overlaps on the supply side. Other concerns included the targeting of schemes towards large, high-tech firms, cultural gaps between support agencies and SMEs, insufficiently high priority given to technology transfer, and burdensome and inflexible bureaucracy.

Exchange between regions served mainly to provide the regions involved with tools and lessons to better manage their own projects. Focus on key ideas, and learning from comparison regarding the management of RITTS projects, were the main benefits of transnational collaboration expressed by the regions. In most cases, an international dimension was supplied by the consultants, but the interregional dimension remained weak. The barriers to effective exchanges included language and cultural differences, travel costs, and an undue emphasis on promotional activities rather than learning.

Most commonly identified unsatisfied needs

Figure 5.2

For one-third of the RITTS:

- lack of innovation financing and risk capital
- lack of staff in firms skilled in dealing with innovation

For 20% of the RITTS:

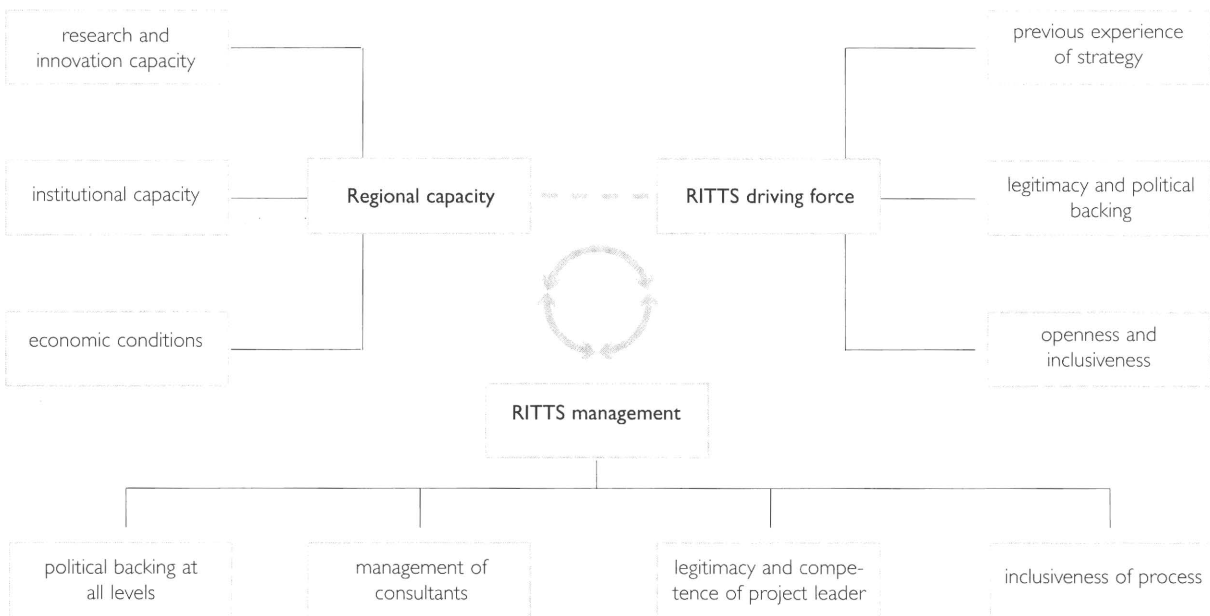
- lack of marketing skills
- lack of managerial skills
- too few innovative start-ups
- low level of innovation in firms, especially sub-contractors
- weak co-operation between firms

To a lesser extent:

- negative attitude in firms towards change and innovation
- need for technological information/intelligence
- lack of openness and low level of internationalisation in firms
- firms' difficulties in expressing their innovation needs
- need to review intellectual property rights
- weak contribution of SMEs to the design of R&D programmes and policies
- lack of relevant technical support in specific sectors

Underlying factors behind RITTS 'successes' and 'failures'

Figure 5.3



Impact of the RITTS projects

RITTS achieved its objective to support regional policy-makers in upgrading their technology transfer and innovation infrastructure. In addition, it contributed rather more to the development of policy than was expected. But it is also clear that the programme as a whole was too ambitious for most regions, which selected and adapted objectives to suit their own circumstances.

In evaluating the success of the projects, it is important to realise that the regions did not all start from the same point. The mark of success should not be "how much did this region achieve?", but "how far did the region improve its position compared with its starting situation?" In many cases, the RITTS project seems to have been an important stage in a long-term process of building an effective innovation policy.

Three main factors contributed to the success of individual projects (Figure 5.3). First, the presence of an existing innovation policy helped give direction to the RITTS project. Second, regions with a strong identity backed up by a regional government tended to do better than regions which existed only on a map. A third factor, which became apparent during the projects, was the crucial importance of good project management. This meant strong political backing, sound management of consultants, project leaders with a high legitimacy and capacity, and intense involvement of all regional stakeholders.

To sum up, the RITTS programme had positive impacts in four areas:

- It encouraged a much-needed move towards strategic thinking for innovation-oriented regional development.
- It offered mechanisms and incentives to create regional dialogue in geographically, institutionally or culturally fragmented regions.
- It promoted the development of a concept of innovation broader than linear technology transfer, and helped to raise this higher on the policy agenda.
- It assisted many regions to clarify the components of their innovation support infrastructures, and to develop actions to rationalise them and augment their visibility.

CHAPTER:	1. Innovation policy			2. Technology transfer		3. Innovation financing			4. Innovation management			5. Regional issues
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Forthcoming Studies

The 12 Innovation Policy Studies summarised in this volume form part of an ongoing series. The following studies are currently in progress, and their reports will be made available by December 2001:

Corporation tax and innovation: issues at stake and review of experience in the 1990s in the European Union and the United States

A comprehensive comparative analysis of tax incentive schemes designed to promote innovation investments in firms will identify their rationale, characteristics, similarities and differences, analysing their influence on the innovation performance of European businesses and identifying good practice. The impact of corporate taxation on intangible investments will also be assessed. The conclusions of the study are expected to contribute to the debate regarding reforms of legislation and practice in this field.

Innovation policy issues in six applicant countries: the challenges

Focusing on Hungary, Poland, Czech Republic, Slovenia, Estonia and Cyprus, this study will examine the current framework conditions for selected innovation issues, analysing the views and policies of public authorities in these countries responsible for promoting innovation among enterprises, especially SMEs. It will also gather opinions from a representative group of private market operators on the innovation framework and innovation investment trends.

Innovative SMEs and employment creation

Building on previous research in this field, this study will further explore the complex relationships between innovative SMEs and the creation of employment, in order to shed light on what can and what cannot be expected from innovative SMEs in terms of employment creation.

Industrial relations and innovation

This study aims to provide policy-makers with practical means to analyse, benchmark and improve the framework conditions which determine the 'innovation-friendliness' of industrial relations in a given sector, region or country, in order to foster change and European competitiveness. It will also be of interest to managers, employee representatives and trade union officials.

■ Patent protection of computer programs: impact assessment on innovative SMEs of future patent reform relating to computer program inventions

This study will draw up a clear and reliable picture of the intellectual property rights (IPR) awareness of small and medium sized enterprises active in the software sector, formulating options on intellectual property rights awareness actions to accompany forthcoming legal changes.

■ Free patent information on the internet: impact assessment

This study will develop an accurate assessment of the present status of freely available online patent information originating from Europe, Japan and the United States, and of users' ease of access to this information. It will also study the use made of these databases and their impact, both on commercial patent databases and on patent awareness in general, formulating options for improving the use of these new tools by researchers, universities and innovative SMEs.

■ The internet and technology transfer

The use of the internet as a vehicle for information exchange and business transactions could have a significant impact on technology transfer activities. Aimed at technology transfer professionals, company managers, researchers, and policy-makers, this study will contribute to the understanding of this trend, with a view to improving its effectiveness.

■ Co-operation between the research system and industry to promote innovative firms

This study aims to identify the major actors and mechanisms of co-operation between the research system and industry, and to identify legal, administrative and financial frameworks needed to stimulate the creation of new firms by research institutions. It will also assess existing co-operative schemes involving research organisations and their spin-off firms, and review the incentives motivating individuals to become entrepreneurs. Finally, it will identify potential synergies and conflicts between research organisations and their spin-off employees.

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Building an Innovative Economy in Europe
A review of 12 studies of innovation policy and practice in today's Europe

This brochure reviews and summarises the first 12 reports in a series of Innovation Policy Studies published by the European Commission's Directorate-General for Enterprise. Addressing priority policy issues related to company-level innovation and its framework conditions, the studies contribute to the strengthening of Europe's innovative performance by giving its political, industrial and institutional decision-makers access to authoritative and up-to-date analyses of current innovation activity, emerging barriers and needs, and the results of existing policy instruments.

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