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ENHANCING THE COMPETITIVENESS OF SMEs
IN THE GLOBAL ECONOMY: STRATEGIES AND POLICIES

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Workshop 1

ENHANCING THE COMPETITIVENESS OF SMEs THROUGH INNOVATION

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FOREWORD

This background report has been prepared by Bénédicte Callan and Jean Guinet of the Science and Technology Policy Division of the OECD Directorate for Science, Technology and Industry. It draws from papers prepared for the OECD by a number of experts, in particular: David Audretsch, Bart Clarysse and Vincent Duchêne. It has also benefited from the substantive comments of Andrea Bonaccorsi, Anna Buzzonetti, Mario Cerchia and Gian Maria Gros Pietro.

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SME INNOVATION IN A GLOBAL ECONOMY [*]

This paper serves as the background document for the Workshop on "Enhancing the Competitiveness of SMEs through Innovation" at the Bologna conference.

Highlights

- *For SMEs in the OECD, economic globalisation has created new competitors, especially in low labour cost countries, but also greater incentives and opportunities to access the various markets and knowledge sources needed to build lasting competitive advantage through continuous innovation.*
- *SMEs are a heterogeneous population of firms whose contributions to the innovation system are wide ranging and include not only R&D based new products and services, but also improved designs and processes and the adoption of new technologies.*
- *Strategies to enhance the global competitiveness of innovative SMEs should take into account that:*

  -- New information and communication technologies facilitate global reach and help reduce the disadvantage of scale economies which small firms face in all aspects of business.

  -- Flexible specialisation has proven to be a particularly successful model of industrial organisation: through close co-operation with other firms SMEs can take advantage of knowledge externalities and rapidly respond to market changes.

  -- Despite economic globalisation and the ability to transmit information rapidly and cheaply, geographic boundaries still matter. Clustering is particularly important to gain access to new ideas and tacit knowledge, especially in young industries.

  -- Specialisation in a market niche compensates for some of the disadvantages of small scale.

  -- While there are more hurdles to overcome for a small firm setting up affiliates abroad, the benefits in terms of access to new markets and knowledge can be immense.
- *Despite the fact that globalisation reduces the degrees of freedom governments have in their policy responses, they can still play an important role in encouraging SMEs to innovate and to implement the strategies required to effectively meet the globalisation challenge, through appropriate regulation, incentives, and institutional learning.*
- *However because of the heterogeneity of the SME population, any policy to increase their innovative capacities must be targeted to meet the needs of a variety of user groups, have different objectives, and use multiple approaches and tools.*
- *For "High-tech" SMEs (the technology developers or lead technology users), which make up less than 15% of the total SME population, the most important goals are to promote the development of the private venture capital industry and associated services, and to adjust accordingly the management and objectives of public R&D granting programmes.*
- *For the vast majority of SMEs (the technology followers), novel technology and innovation policies should better address their needs, especially in regards to: non-financial innovation advice such as consulting services; recruitment of university graduates and skilled personnel; awareness of new ideas and technologies; and incentives and institutional frameworks for improving collaborations within networks and clusters, including local technical centres or technical colleges.*

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[*] This background paper was based on material provided by David Audretsch (Indiana University), Bart Clarysse and Vincent Duchêne (KwantiConsult) and Vlerick Leuven (Gent Management School at the University of Gent), with contribution from Gian Maria Gros Pietro, Andrea Bonaccorsi, Anna Buzzonetti, and Mario Cerchia..

Introduction

1. The contribution of small firms to innovation-led growth and job creation[1] has been of renewed interest in recent years. A large body of evidence shows that SMEs, especially young firms, contribute greatly and increasingly to the innovation system by introducing new products and adapting existing products to the needs of customers. This explains why economists have reopened the debate on whether some market and systemic failures disproportionately_affect small firms, and why governments have generally increased the priority attached to policies directed towards SMEs while focusing them more on the promotion of innovation. These policies must take into account the challenges and opportunities that new technologies and globalisation raise for small firms. They must also find the right balance between measures addressing generic problems related to size or newness and more targeted responses that are tailored to the varying needs of the main different types of SMEs.

2. This paper first identifies the challenges and opportunities that globalisation raises for SMEs as they are faced with pressures to reduce production costs, increase productivity, and become more knowledge intensive. It then discusses what is known about how different types of SMEs innovate, and identifies the principle strategies SMEs can pursue to enhance their competitiveness in global markets. Finally the paper draws the implications for government policies.

Globalisation Challenges

3. Both scale economies and research and development have become more important instruments for competitiveness in the global economy. Since SMEs seem to be at a disadvantage for both these factors, many experts predicted the demise of SME competitiveness as globalisation increased. While many SMEs have indeed succumbed to a deterioration of competitiveness, others have found ways to actually enhance their positions in global markets. The actual record of the competitiveness of SMEs in the OECD countries has been heterogeneous and complex due to the sheer numbers of SMEs, which span a broad range of economic activities in a disparate set of industries across different countries.

4. This section briefly explains what triggered the wave of globalisation reshaping the economy at the end of the 20th century. To understand globalisation's impact on SME innovativeness, it is important to think about the underlying determinants shaping globalisation, since it is the ability of SMEs to adjust to those forces that can enhance their competitiveness. One of the most important implications of globalisation is that the comparative advantage of OECD nations is shifting away from traditional factors of production, such as land, labour and capital, towards knowledge-based economic activities. The ability of SMEs in the OECD to create, access and commercialise knowledge on global markets will be the fundamental source of their new competitiveness in global markets.

Globalisation

5. Perhaps the most radical change in the economic landscape of the end of the 20th Century has been the shift in economic activity away from a local or national sphere toward a much more international or global. The measures of trans-national economic activity which prove there has been a strongly positive trend toward greater global activity include: statistics on trade flows (exports and imports), foreign direct investment, international capital flows, and inter-country labour mobility. But in order to answer how these

1 . During the last five years, SMEs were responsible for more than 80% of the jobs created (European SME co-ordination unit, CEC, 1999).

aggregate trends affect the innovative capacity of SMEs, it is necessary to think about the underlying factors driving globalisation forward.

6. One of the major forces enabling economic globalisation has been technology. In particular, the advent of the microprocessor and the proliferation of inexpensive communications technologies have completely altered the economic meaning of national borders and distance. Observing the speed and minimal cost with which information can be transmitted across geographic space via the Internet, fax machines and electronic communication superhighways, *The Economist* recently proclaimed "The Death of Distance" on its front page.[2] While the telecommunications revolution has brought the cost of transmitting information across geographic space to virtually zero, the microprocessor revolution has vastly expanded the ability of many to participate in global communications and to use transmitted information. Most inferences about the degree of globalisation that rely on international trade statistics miss an important point: it is the *quality*, and not just the quantity, of international transactions that have changed. No longer are international transactions arms-lengths interactions among corporations, they concern now interactions of individuals and expose people to ideas and experiences that were previously inaccessible.

The Emergence of Knowledge as the Source of Comparative Advantage

7. Confronted with lower cost competition in foreign locations, producers in the high-cost countries have been confronted with five strategic options in responding to globalisation: (1) change nothing and suffer losses of profitability and market share; (2) reduce wages and other production costs sufficiently to compete with the low-cost foreign producers, (3) substitute equipment and technology for labour to increase productivity, and (4) shift production out of high-cost and into low-cost locations; and (5) shift into knowledge-based economic activities.

8. While some firms fell victim to the first strategy, many of the firms from OECD countries that have successfully restructured resorted to alternatives 2, 3 and 4. Reducing wages has helped to maintain or at least minimise job losses in some industries in some countries. However, the cost is at lower living standards. Substituting capital and technology for labour, along with shifting production to lower-cost locations has resulted in waves of corporate downsizing throughout Europe and North America. (Although it has also preserved the viability of many of the large corporations.) Between 1979 and 1995 more than 43 million jobs were lost in the United States as a result of corporate downsizing.[3] Perhaps most disconcerting is the fact that the rate of corporate downsizing is apparently increasing with time in the United States, even as the unemployment rate is falling. During the 1980s, one in about 25 workers lost a job, and in the 1990s the figured has risen to one in 20 workers.

9. Much of the policy debate about globalisation has revolved around a trade-off between maintaining higher wages at the cost of higher unemployment *versus* favoring higher levels of employment at the cost of lower wage rates. Globalisation has rendered the comparative advantage in traditional moderate technology industries incompatible with high wage levels. There is an alternative, however. It does not require sacrificing wages to create new jobs, nor does it require fewer jobs to maintain wage levels and the social safety net. This alternative involves shifting economic activity out of traditional industries, where the high-cost countries of the OECD have lost their comparative advantage, and into those knowledge-based industries where comparative advantage is compatible with both high wages and high levels of employment – knowledge based economic activity. Emerging comparative advantage that is

2 "The Death of Distance," *The Economist*, 30 September, 1995.

3 "The Downsizing of America," *New York Times*, 3 March, 1996, p. 1.

compatible with high wage levels is based on innovative activity. In Silicon Valley, for example, employment has increased by 15% between 1992 and 1996, even though the mean income is 50% greater than in the rest of the country.[4] In 1997 Silicon Valley created more than 53,000 new jobs, while its wages grew at nearly twice the national average.

10. The global demand for innovative products in knowledge-based industries is high and growing rapidly; yet the number of workers who can contribute to producing and commercialising new knowledge is limited to a few areas in the world. Many indicators in fact that show the shift in the comparative advantage of the high-wage countries towards an increased importance of innovative activities. For example, the information sector of the United States has experienced an increase in the annual growth rate from 5% in 1991 to nearly 20% by 1998. By contrast, the rest of the economy experienced fairly steady growth at around 3% over this period.[5] Innovative activity of in the United States has jumped, as evidenced by the explosion in applications for United States patents by American inventors since 1985. Throughout this century, patent applications fluctuated within a band between 40,000-80,000 per year. By contrast, in 1995 there were over 120,000 patent applications. Furthermore, demand for less skilled workers has decreased dramatically throughout the OECD, while demand for skilled workers has exploded.[6]

11. Given the shift in comparative advantage towards more knowledge based economic activity, many scholars have predicted the demise of SMEs. But in fact, the share of economic activity accounted for by SMEs has risen in most OECD countries. While some SMEs, like their larger counterparts, have fallen victim to globalisation, still others have deployed strategies to maintain or even enhance their competitiveness in a globalizing economy. This background paper discusses some of the strategies open to SMEs as they try to become more productive and shift more knowledge-based activities.

Innovation in SMEs

12. Despite the fact that SMEs account for a very small fraction of total business R&D in the OECD, a large body of evidence shows that SMEs contribute greatly to the innovation system by introducing new products and adapting existing products to the needs of customers. Small firms account for a disproportionate share of new product innovation given their low R&D expenditures (Acs and Audretsch, 1990).

The Role of Small Firms in Innovation Systems

13. While it is true that a number of empirical studies relating R&D to firm size show that large firms undertake considerably more R&D, more recent evidence suggests that SMEs play an important role in R&D activity. Investment in innovative activities seems to be on the rise in SMEs. The National Science Foundation (1999) shows that total expenditures for industrial R&D by SMEs has increased by almost three times between 1985 and 1995 in the United States, while in the largest firms, the increase has been only about 20%. The National Science Foundation also found an increase in the R&D-sales ratio from 3.4% in 1985 to 3.9% in 1995 for SMEs, whereas the R&D-sales ratios of the largest corporations fell from 3.5% to 3.1%.

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[4] "The Valley of Money's Delights," *The Economist*, 29 March, 1997, special section, p. 1.

[5] Kortum and Lerner 1997, p. 1.

[6] Berman, Bound and Machin (1997).

14. Evidence also shows that the propensity to patent, which is a mesure of the production of new technological knowledge, tends to *increase* as firm size *decreases*. Bound et al. (1984) examined 2 852 U.S. companies and 4 553 patenting entities, and determined that the small firms (with less than $10 million in sales) accounted for 4.3% of the sales from the entire sample, but 5.7% of the patents. Similarly, a German study (Schwalbach and Zimmermann, 1991) found that the propensity to patent is more for SMEs than for the largest firms in Germany.

15. A number of studies since the 1980s have tried to measure innovative output directly, often by compiling lists of new significant innovations using external evaluations, the literature, and firm opinions about major changes in industrial products and processes (Gellman Research Associates, 1976 and 1982; Rothwell, 1989; Audretsch, 1995; Brouwer and Kleinknecht, 1996). Using such direct measures of innovative activity SMEs come out as being more innovative than their larger counterparts. For example, the Gellman (1976, 1982) data base identified SMEs as contributing 2.45 times more innovations per employee than do large firms. Audretsch (1995) identifies SMEs as contributing 2.38 times more innovations per employee than do large firms. Other studies identifying different types of output measures have generally confirmed these findings for other countries than the US.

16. The relative advantages as innovators of SMEs *versus* large corporations vary systematically across manufacturing industries. For example, Audretsch (1995) has demonstrated that SMEs contribute more to innovative activity in electronic computing equipment and process control instruments, but large corporations contribute more in pharmaceuticals and aircraft. The differences between the innovation rates of large corporations and SMEs can generally be explained by (1) the degree of capital intensity: (2) the extent to which an industry is concentrated; (3) the total amount of innovative activity in the industry; and (4) the extent to which an industry is comprised of large corporations. In particular, large corporations tend to have an advantage in industries that are capital intensive, advertising intensive, concentrated, and highly unionized. By contrast, SMEs have the upper hand as innovators in industries that are highly innovative and comprised predominantly of a large corporations.

17. The realization that SMEs play an active role in innovation has led to a number of insights about the mechanisms by which SMEs improve and introduce new products and services. Rothwell (1989) suggests that small firms can have an innovative advantage due to differences in management structures. Similarly, Scherer (1991) argues that the bureaucracy in large firms is not conducive to undertaking risky R&D, as decisions must survive several organisational layers of resistance, where an aversion to risk results in a bias against undertaking new projects. In an SME, the decision to innovative is made by a small number of people. Innovative activity also flourishes in environments free of bureaucratic constraints (Link and Bozeman, 1991). A number of SMEs have in fact benefited from the exodus of researchers thwarted by the managerial restraints of larger firms. Finally, larger firms also tend to promote successful researchers to management positions, while SMEs can place innovative activity at the center of their competitive strategy (Scherer, 1991).

18. Scherer (1988) has summarized the advantages SMEs may have in innovative activity: “Smaller enterprises make their impressive contributions to innovation because of several advantages they possess compared to large-sized corporations. One important strength is that they are less bureaucratic than more highly structured organization. Second, and something that is often overlooked, many advances in technology accumulate on a myriad of detailed inventions involving individual components, materials, and fabrication techniques. The sales possibilities for making such narrow, detailed advances are often too modest to interest giant corporations. An individual entrepreneur’s juices will flow over a new product or process with sales prospects in the millions of dollars per year, whereas few large corporations can work up much excitement over such small fish, nor can they accommodate small ventures easily into their organizational structures. Third, it is easier to sustain a fever pitch of excitement in small organization,

where the links between challenges, staff, and potential rewards are tight. 'All-nighters' through which tough technical problems are solved expeditiously are common."

Different Forms of Innovation

19. Nevertheless, SMEs are a very heterogeneous population of firms, and can include everything from the corner hairdresser and grocer to high technology firms. In some industries the bulk of innovations – be they new products or processes – are introduced by new entrants or start-ups who challenge incumbents' market shares (and occasionally displace incumbents entirely). But in many other industries, SMEs contribute to the innovative process in a very different way. Relying on a minimum of internal R&D, SMEs can create innovative products by using non-R&D inputs. So while some SMEs in high tech sectors can make intense use of science-based knowledge and are active technology developers, most SMEs operate in medium to low technology environments and innovate without using formal R&D inputs. This is consistent with economic theories of innovation and technical change where inputs to the innovative process are understood to be heterogeneous and not limited to formal R&D investments.

20. In a more systematic approach to understanding innovation in SMEs, the European Community Innovation Survey (CIS) distinguishes between R&D and non-R&D based innovation. The CIS has shown that the pattern of innovation in SMEs is mostly non-R&D investment based. Only as firm size increases does the importance of R&D investment in innovation increase too. For SMEs, non-R&D inputs are more important and can be of two types: (1) capital equipment or input-embodied innovation, and (2) design innovation. In capital equipment based innovation firms acquire new process technologies or intermediate products which allow them to benefit from innovations developed elsewhere. Design innovation, on the other hand, refers to incremental improvements in products that do not radically change their function or technological base, but allow firms to better meet customer requirements. The role of design innovation for SMEs must be stressed. Design is only a small part of the complete R&D cycle and does not necessarily require access to scientific knowledge or advanced engineering technology. However, design is an enormously rich inventive and creative activity, which opens large opportunities to improve products. Traditional accounts of R&D largely under-evaluate the subtleties of innovative design which require a deep understanding of product function in relation to customer requirements; a strong command of all technical interdependencies within product components; and a clear appreciation of constraints posed by the manufacturing system. It is a highly synthetic professional capability and one important to many SMEs.

21. The European Commission (1994, 1998) and IRDAC (1988) have used large-scale surveys to characterise innovation in the total SME population. Drawing on these surveys, SMEs can be roughly segmented into three groups:

- Technology developers, which make up only 1-3% of the total SME population.
- Leading technology users (of varying R&D capacity[7]), which are 10-15% of SMEs.
- Technology followers, totalling between 80-85% of the population.

[7] The distinction between leading technology users *with* and *without* sufficient R&D capacity might need some further explanation. The definition of R&D capacity lies very close to Cohen and Levinthal's (1991) definition of 'absorptive capacity', i.e. having a critical mass which guarantees the ability to recognise and adopt interesting technologies and incorporate them into existing products or new products, familiar to the firm. Since such a critical mass is firm idiosyncratic, there is no simple way to segment the population a priori into SMEs *with* and *without.* This does not mean that the distinction is not useful. The technology policy institutes might take into account the fact that some of their main potential clients may need help in *recognising* new technologies because they lack the critical mass.

22. The technology developers include two main groups of SMEs: (1) high tech, potentially high growth firms and research oriented consultancies which include engineering services, technology consultants, and (2) R&D boutiques. As shown in table 1, the technology developing companies tend to be small and young.

23. The leading technology users include two main subgroups: those with sufficient R&D capacity to perform R&D projects themselves and those that cannot.

24. The technology followers represent 80-85% of the SME population but, according to a Dutch survey -- which delved further into SME implementation of IT, organisational dynamics, strategy, and new product introduction – they can be further segmented into potential innovators (which are about 40% of the population) and non innovators (40-45%). (See Ministerie van Economische Zaken, 1997) Technology followers who are potential innovators have the following characteristics:

- They employ some higher educated people (with a university degree or the equivalent).
- They have introduced at least one new product on average.
- They care about client satisfaction and recognise the value of market research.
- They are willing to collaborate with other companies.
- They seldom receive subsidies.
- They seldom own patents.

25. In contrast, many SMEs do not see innovation as part of their business strategy. They often use old manufacturing processes; rarely work with other companies; have no development activities; and rarely bring new products on the market. This latter group of SMEs is not further discussed in this background document.

Table 1: Key Characteristics of different types of SMEs

	Technology developers	**LEADING TECHNOLOGY USERS** *(2 sub groups: with and without R&D capacity)*	*Technology Followers*
SIZE	Often small companies (40% have staffs <10 ; 23% have staffs > 250)		
SECTOR	Predominantly from the following sectors: ICT services, high tech[8], R&D services. 50% are technical service companies (ICT, R&D)	Both from manufacturing and services, but less from the high tech sectors	Low tech manufacturing industry ; rarely from services industries
AGE	Younger companies than average (33% are less than 5 years against 24% for all participants in FP)	59% were created over 10 years ago	64% of were created more than 10 years ago
AFFILIATION	Include more spin-offs from universities and research labs		
R&D ACTIVITIES	Invest significantly in research (75% invest more than 20% of	Invest on average about 11% of their turnover in R&D	Invest less than 5% of their turnover in R&D

8 Biotechnology, electronics and telecommunication, industrial software applications, new materials

	their turnover)		

Source: Clarysse and Duchêne, 2000. As cited in the SME co-ordination unit, DG Research.

26. SMEs are thus a large and very heterogeneous group of firms whose investments in and use of innovations cannot be uniformly characterised. SMEs fall roughly into four subgroups. Less than 20% of all SMEs – the technology developer and leading technology user groups – are active innovators. Over 80% of SMEs are technology followers, but close to half of these have the potential to be more innovative. However, each of these sub-groups of firms has very different innovation needs. Thus any discussion of how to increase the innovative capacity of SMEs must start from an understanding that technology policies for SMEs must be targeted to different user groups, have different objectives, and use several approaches and tools.

27. However, in most countries innovation programmes that subsidise R&D are organised along different technology domains or sectors rather than targeted towards the sub-groups of companies outlined above. A great deal of policy attention has been paid to the technology developers, and an increasing number of countries have introduced special SME programmes to promote high technology start-ups. Only a small number of countries however, make a clear distinction between the different kinds of SMEs, or tailor their SME policies to help a broad cross section of these firms access and absorb knowledge that might improve their innovativeness. As we shall see later, government policy can do much more to help the majority of SMEs manage the transition to a global, knowledge based economy.

Competitiveness Strategies

28. The ability of SMEs to create, access and commercialise new knowledge on global markets is fundamental to their sustained competitiveness. This section identifies some of the principle strategies SMEs have pursued on their own, including:

- The *innovation strategy*, in which SMEs try to appropriate returns from their knowledge base (which may or may not involve own investments in R&D).
- The *information technology strategy*, which makes innovative uses of information technology in order to reduce SME costs and increase productivity.
- The *niche strategy*, in which SMEs choose to become sophisticated global players in a narrow product line.
- The *network strategy*, in which SMEs work and co-operate with other firms, be they SMEs or large enterprises in order to improve their ability to access and absorb innovations.
- The *cluster strategy*, in which SMEs locate in close proximity with competitors in order to take advantage of knowledge spill-overs, especially in the early stages of the industrial lifecycle.
- The *foreign direct investment strategy*, in which SMEs exploit firm-specific ownership advantages abroad.

29. This section describes in greater detail the innovation strategies that have enhanced the competitiveness of SMEs in global markets.

The Innovative Strategy

30. One of the important sources of competitiveness for SMEs has been to serve as *agents of change*, as the engines for new idea generation and innovative activity. However, that SMEs would pursue innovation as a strategy for competitiveness at all seems to run contrary to many of the conventional theories of innovation.

31. The starting point for most theories of innovation is the firm. In the literature of technological change, for example, the most accepted model of the knowledge production function which was formalised by Zvi Griliches (1979) assumes that firms exist exogenously and that firms engage in the pursuit of *new* economic knowledge as an input into the process of generating innovative activity. But knowledge as an input is inherently different than the more traditional inputs of labour, capital and land because the value of knowledge is intrinsically uncertain and its potential value is asymmetric across economic agents.[9] *Investing in new knowledge is a risky activity that most SMEs cannot justify.* The most important (though not the only) source of new knowledge is research and development (R&D). Other key factors generating new economic knowledge include a high degree of human capital, a skilled labour force, and the strong presence of scientists and engineers.

32. Empirical evidence supports knowledge production function model. The empirical link between knowledge inputs and innovative output becomes stronger as the unit of observation becomes increasingly aggregated. For example, if the unit of observation is countries, the relationship between R&D investments and patenting is very strong. The most innovative countries, such as the United States, Japan and Germany, also tend to undertake high investments in R&D. By contrast little patent activity is associated with developing countries, which have very low R&D expenditures. Similarly, the link between R&D and innovative output, measured in terms of either patents or new product innovations is also strong when the unit of observation is the industry. The most innovative industries, such as computers, instruments and pharmaceuticals also tend to be the most R&D intensive (Audretsch, 1995). However, when the knowledge production function is tested for the unit of observation of the firm, the relationship between knowledge inputs and innovative output becomes much more tenuous, and is particularly weak when small firms are included in the sample.

33. The breakdown of the knowledge production function at the level of the firm raises the question, *Where do innovative firms with little or no R&D get the knowledge inputs?* This question is particularly relevant for new SMEs that undertake little R&D themselves, yet contribute considerably to innovation in newly emerging industries like biotechnology and computer software (Audretsch, 1995). One answer is that knowledge inputs come from third-party firms or research institutions, such as universities. Economic knowledge spills-over from other firms conducting the R&D or from university research laboratories. But why should knowledge spill over from the source of origin? At least two major spillover channels are identified in the literature and both have their origins in the issue of knowledge appropriability. Cohen and Levinthal (1989) suggest that some firms develop the capacity to *adapt* new technology and ideas and are therefore able to appropriate some of the returns accruing to investments in new knowledge made externally. In contrast, Audretsch (1995) proposes shifting the unit of observation to the unit of the individual – the scientists, engineers, and other knowledge workers – as agents endowed with new economic knowledge.

34. When the focus shifts from the firm to the individual as the relevant unit of observation, the appropriability issue remains, but the question becomes, *How can economic agents with a given endowment of new knowledge best appropriate the returns from that knowledge?* If a scientist or engineer can pursue a new idea within his firm's organisational structure, and if he can roughly appropriate the

9 Arrow (1962) pointed out this is one of the reasons for inherent market failure.

expected value of that knowledge, he has no reason to leave. On the other hand, if he places a greater value on his ideas than does his original firm, he may choose to start a new company to appropriate the value of his knowledge. Using the metaphor provided by Albert O. Hirschman (1970), if voice proves to be ineffective, and loyalty is sufficiently weak, a knowledge worker may choose to exit the firm or university where the knowledge was initially created. In this spillover channel the knowledge production function is actually reversed. Knowledge is exogenous and embodied in a worker. The firm is created endogenously through the worker's effort to appropriate the value of his knowledge through innovative activity.

35. What emerges from new evolutionary theories and the empirical evidence on innovation as a competitive strategy, is a picture of markets in motion with a lot of new firms entering and industry and a lot of firms exiting. But is this motion *horizontal*, with the bulk of exiting firms relatively recent entrants, or *vertical*, with a significant share of exiting firms being established incumbents displaced by younger firms? In some industries the dynamics are best understood using the revolving door metaphor: new businesses enter but with a high probability of subsequent exit. Other industries are better characterised using a forest metaphor: new entrants displace incumbents. Which metaphor is most apt depends on a given industry's underlying technological conditions, scale economies, and demand. Where scale economies are important, the revolving door model is more common. While start-ups and new entrants may not be deterred by the presence of high scale economies, a process of firm selection ensures that only those firms that grow will be able to survive beyond more than a few years.

36. When SMEs engage in a strategy of innovation, they typically start at a very small output scales. Empirical evidence shows that the post-entry growth of surviving new entrants tends to be spurred by the extent to which there is a gap between the MES level of output and the size of the firm. However, the likelihood of any particular new firm surviving tends to decrease as this gap increases. Only those SMEs offering a viable product that can be produced efficiently will grow and ultimately approach or attain the MES level of output. The remainder will stagnate, and depending upon the severity of the other selection mechanism - the extent of scale economies - may ultimately be forced to exit out of the industry. Thus, in highly innovative industries, there is a continuing process of the entry of new SMEs and with low levels of individual SME survival. Although a skewed size distribution of firms can persist with remarkable stability over long periods of time, it is not due to a constant population of SMEs. Rather, by serving as agents of change, SMEs provide an essential source of new ideas and experimentation that otherwise would remain untapped in the economy.

The Information Technology Strategy

37. A second strategy SMEs can use to improve their competitiveness in global markets involves the application and adoption of new technologies that effectively serve to reduce costs. A number of significant new technologies, which include the Internet and the microprocessor, help mitigate economies of scale and the gains traditionally associated with large-scale production. A classic example is the adoption of numerically controlled (NC) machine tools in the manufacturing industries. NC machine tools have contributed to a reduction in the minimum efficient scale (MES), or the level of output required to reach scale economies. This notion has received considerable attention in the popular press. Management consultant Tom Peters claims that, "Old ideas about economies of scale are being challenged. Scale itself is being redefined. Smaller firms are gaining in almost every market... Even the smallest of firms can engage in certain activities -- from plant watering to specialised legal services -- better than a giant corporation. So we see a spreading trend toward de-integration and subcontracting."[10]

[10] Tom Peters, "New Products, New Markets, New Competition, New Thinking," *The Economist*, 4 March, 1989, pp. 27-32.

38. New web-based information technologies are enabling SMEs to attain global marketing capabilities at very low costs. SMEs are also using electronic commerce and internet-based access to products like financial and accounting management software systems that enhance organisational and management capabilities, while at the same time reduce the high costs associated with managing SMEs. Such products enable SMEs to create virtual warehouses, where they build direct links between manufacturers and final customers. But to properly take advantage of such internet-based financial and accounting systems, SMEs typically need to modify or change their organisational structure.

39. Ba, Whinson and Zhang (1999) point out that, “In the physical world, scale economy and standardisation plays a major role. The digital world enables individual product customization… The customers will directly interact only with the intermediary, which provides the appearance of having a huge inventory of a wide range of products.” An important strategy deployed by SMEs to create competitiveness in global markets is to use the digital technology to develop core competencies and collaborate with other SMEs to construct innovative content tailored to the unique taste of each consumer.

The Niche Strategy

40. Some enterprises, especially small and medium-sized firms, choose to pursue increasingly specialised markets or innovative niches, which exist both in the home country and in foreign markets. As *Business Week* point out, "U.S. niche players actually create new markets."[11] But what types of companies tend to be involved in creating new markets and occupying specialised niches? *Business Week* observes, "They are companies you never heard of. They produce car-wash systems in Europe and the Middle East, doughnut-making machines in Canada, and aquaculture equipment in the Philippines. On the high-tech front, they make parallel-processing computers for Japan and satellite receivers for Germany."[12]

41. To some extent this is strategy employed by Germany's small- and mid-size companies, commonly referred to as the *Mittelstand*. Many of these small and medium-sized companies – which include companies like Krones, Körber/Hauni, Weinig, Webasto, and Terta Werke – are not well known by the public. Yet the global market share of these companies typically far exceeds that of the giant companies of Germany. When calculated in terms of the specialised products they manufacture, the Mittelstand companies have between 70 and 90% of global market shares and account for the bulk of the German international trade surplus.

42. One of the major strategic instruments deployed by the Mittelstand companies is the combination of product specialisation with geographic diversification. Typically these firms focus on a particular market niche, usually one that requires technical expertise, and company resources are devoted to maintaining market leadership in that niche. Diversification is generally considered to be anathema to focusing upon the core product. But because of their specialisation and small size, Mittelstand companies are often at a disadvantage in terms of economies of scale. The second part of their strategy is thus to have global presence. Product-market specialisation is leveraged across broad geographic markets, so that globalisation of marketing and sales creates sufficient scale to recover R&D expenses and to maintain costs at a reasonable level. An executive of a company that makes laboratory equipment explained that the typical Mittelstand strategy, "If you are small, your front of attack has to be narrow. You'd better focus your business. And if you are focused, you have to find customers for your speciality all over the world in order to recoup your R&D investment."

[11] "The Little Guys Are Making It Big Overseas," *Business Week*, 27 February 1989, pp. 67-69.

[12] *Ibid*., p. 67.

43. The German Mittelstand are indeed hidden economic champions. One study (Simon, 1992) showed that these companies accounted for an average of 22.6% of the global market share in the relevant product markets, and 31.7% of the European market share. Each company had, on average, 9.6 foreign subsidiaries -- certainly an extraordinarily high number of foreign subsidiaries given the rather modest size of the parent companies. Foreign direct investment plays a central role in these companies. And their five-year revenue growth was 16.2%, while five-year employee growth was 9.8%.

44. One of the keys to the success of the German *Mittelstand* has been their strong commitment to global expansion. They investment abroad in plant, equipment, and technology, and they investment in people. Even when a high initial investment may not be justified in terms of short-term returns, the small and medium-sized enterprises consider it important to undertake such global investments because of the demonstration effect -- to show potential customers and business partners that they are committed to the local economy. The *Mittelstand* companies also espouse a strategy whereby they insist on the same high standards in the host market as they do in the home market, particularly in servicing their production through the creation of strong and reliable service networks. It is through such an aggressive strategy of expansion of production in foreign markets that these German *Mittelstand* companies have been able to overcome the inherent size disadvantage. Nevertheless, the small- and medium-sized enterprises of Germany have not been able to overcome the risks inherent in a high degree of specialisation, and especially their vulnerability to market changes.

45. Despite their specialisation, the German *Mittelstand* companies pursue a strategy that is not blindly committed to the technological frontier. Their focus is rather on the interface of technology and customer needs, a commitment that takes numerous forms. For example, the German *Mittelstand* are very good at customer training. As the complexity of products increases, the customer requires more instruction in operating and maintaining products, which the Mittelstand provide. It is the combination of being oriented to both a specialised product niche, typically combining both sophisticated technology with careful devotion to consumer needs, that makes a strategy of foreign direct investment so central to the German *Mittelstand*. In order to understand the peculiarities of each host market, the company benefits by producing at the location of the host market. Apparently the knowledge that is transmitted, which involves a large tacit element, is best accessed by close geographic proximity. Local presence is also important in order to provide services, such as training, to customers. While such services could be contracted out, the asset specificity of the product, combined with its high technological sophistication, virtually bundles the service component with the manufactured product.

46. In the experience of the German *Mittelstand*, when the technology dominates the enterprise and scientists and engineers are the driving force in the enterprise, customer satisfaction tends to suffer and demand shifts elsewhere. Conversely, when the marketing department is the driving force behind the enterprise, technological sophistication is affected. While customers may be satisfied in a static sense, the enterprise is not engaging in dynamic product development, which leaves it vulnerable to competition from more technologically advanced companies. Customers eventually reward technological leaders that can provide them with unanticipated product innovations and improvements. In this sense, balancing conflicting customer demands is a delicate strategy that only a very flexible enterprise, which has both technological competencies and sensitivity to consumer needs, can accomplish. Ideally in SMEs scientists and engineers should have a deep understanding of what their customers actually need, but this can only be nurtured through close and frequent contact with the customers. Such direct and repeated contact between customers and the engineering department is particularly important, so that the latter do not underestimate the problems of applying technology to commercial needs. Indeed, non-marketing employees in the German *Mittelstand* engage in direct contact with customers at twice the frequency as in the largest German corporations. This is typical of the importance placed in German SMEs on having customer interaction with engineering, manufacturing, and financial employees in order to make sure innovative activities truly meet customer needs.

The Network and Flexible Production Strategies

47. A fourth strategy open to SMEs who want to remain competitive in global markets is to actively participate in networks and cooperate with other firms be they other SMEs, large enterprises, or a combination of both. Saxenian (1994) has argued that it is the culture of interdependence and exchange among individuals in Silicon Valley that has contributed to its superior innovative performance, especially when compared to Boston’s Route 128 where firms and individuals are more isolated from one another. In studying the networks in Silicon Valley, Saxenian (1990) emphasised the role of individuals in facilitating the transmission of knowledge across agents, firms, and even industries. Saxenian writes:

> “It is not simply the concentration of skilled labour, suppliers and information that distinguish the region. A variety of regional institutions – including Stanford University, several trade associations and local business organisations, and a myriad of specialised consulting, market research, public relations and venture capital firms – provide technical, financial, and networking services which the region’s enterprises often cannot afford individually. These networks defy sectoral barriers: individuals move easily from semiconductor to disk drive firms or from computer to network makers. They move from established firms to start-ups (or vice versa) and even to market research or consulting firms, and from consulting firms back into start-ups. And they continue to meet at trade shows, industry conferences, and the scores of seminars, talks, and social activities organised by local business organisations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived… This decentralised and fluid environment also promotes the diffusion of intangible technological capabilities and understandings.”[13]

48. These observations suggest that differences in the underlying structure between regions may account for differences in rates of growth and technological change. A heated debate has emerged in the literature about how economic structures within a geographic unit of observation might shape economic performance. The debate revolves around two issues: (1) the degree of diversity versus specialisation in a region, and (2) the degree of monopoly versus local competition.

49. One model suggests that a concentration of firms within a particular industry in a geographic region facilitates knowledge spillovers across firms (the Marshall-Arrow-Romer model). This model formalises the insight that concentration promotes knowledge spillovers among firms and therefore facilitates innovative activity. To the degree that individuals in the population are identical and engaged in identical types of activities, the costs of communication and transactions are minimised, and there is a higher probability that knowledge will spill across individuals in the population. An important assumption is made that knowledge externalities exist only for firms within the same industry. This assumption ignores the potential importance of new economic knowledge from inter-industry spillovers. Jacobs (1969), for one, argues that the most important source of knowledge spillovers are in fact external to the industry in which a firm operates. Cities are the locus of considerable innovation because of the great diversity of their knowledge resources. According to Jacobs, the exchange of *complementary* knowledge across diverse firms and economic agents yields greater returns on new economic knowledge. Jacobs thus develops a theory about how a greater variety of industries within a geographic region promotes knowledge externalities, ultimately innovative, activity and economic growth.[14]

50. There is also theoretic debate about the effect of competition on innovative activity. The Marshall-Arrow-Romer model predicts that local monopoly should be superior to local competition

13 Saxenian (1990, pp. 97-98).

14 For an extension of this see Vernon (1994) and Vernon et al. (1995).

because it maximises the ability of firms to appropriate economic value accruing from their investments in new knowledge, and thus the incentive to innovate. In contrast, Jacobs (1969) and Porter (1990) argue that competition is more conducive to the generation of knowledge externalities than is local monopoly.[15] Not only does a large number of firms result in greater competition for new ideas, but it also facilitates the entry of new, specialised firms since complementary inputs and services are more likely to be available in a diversified competitive environment, than in one dominated by large, vertically integrated producers.

51. Evidence seems to indicate that diversity and local competition did positively influence industry growth rates in US cities from 1956-1987 (Glaeser et. al., 1992). Results of a study by Feldman and Audretsch (1999) indicate that a region characterised by a diversity of firms engaged in complementary economic activities, but who share a common science base, is more conducive to innovation than a more specialised region. In addition, the results of this study indicate that local competition for new ideas within a city is more conducive to innovative activity than is local monopoly. Perhaps the most important conclusions from these two studies, however, is that the underlying economic and institutional structure matters to innovative performance, as does the microeconomic linkages across agents and firms.

52. An alternative system of industrial organisation, called *flexible specialisation*, has seen a re-emergence as a way of linking SMEs into production networks with superior innovative performance. Flexible specialisation refers to the production of small series of specially designed goods of a specific quality, usually for niche markets. Flexible production systems typically have the following five characteristics:

- *Reliance upon multi-purpose equipment*. The use of general purpose equipment enhances the flexibility of these firms to rapidly change product specifications in order to meet customer demands. But doing so requires skilled labour, and high investments in human capital.

- *Continual innovation*. Both the nature of the products, as well as production and organisation methods, are continually being improved.

- *Clustering*. Groups of enterprises working in the same product are seedbeds for the exchange of new ideas. Physical proximity facilitates the transmission of knowledge and also enhances the development of institutions that enhances effectiveness.

- *Networking*. Formal and informal links between enterprises, including subcontracting relationships, facilitate economic specialisation of firms as well as superior access to information.

- *Spillover Effects*. Knowledge created within an enterprise spills over for use by other enterprises.

53. There is considerable evidence supporting the hypothesis that flexible production systems actually outperform those based on mass production. One of the most striking examples of superior economic performance is provided by Emil Roaming, a mixed agricultural-industrial region located in north central Italy. Through flexible production small firms have achieved a better economic performance than large enterprises. In these specialised industrial districts an agglomeration of producers within an industry work in close physical proximity. The narrow division of labour common to large enterprises has been replaced by an organisational structure in which employees perform a wide variety of different tasks.

15 Porter (1990) provides examples of Italian ceramics and gold jewelry as industries in which numerous firms are located within a bounded geographic region and compete intensively for new ideas.

54. It is not the solely the technical superiority of these firms that is makes firms in Italian networks so successful, but the importance of links between firms and individuals. The interaction between customers, manufacturers, and capital good suppliers in Italy has created an environment that pushes innovation forward. Manufacturers make sophisticated and ever changing demands, which push suppliers to provide a continuous stream of incremental innovations. The same is true of the close relations between manufacturers and customers, the latter providing rapid feedback on technical solutions. These links have been supported by national and local government policies as well as by a rich network of private economic associations and political organisations. These firms generally favoured decentralised manufacturing locations in close proximity to other firms within the network in an effort to preserve small effective work groups.

55. The network structure allows firms to reduce costs and spur innovation by co-operating with or subcontracting to external firms. While there is a danger that outsourcing may impose greater transaction costs, might reveal product and design secrets to competitors, or may reduce quality control, most SME owners in Emil Roaming believe that the benefits outweighed these considerations. Higher transaction costs resulting from accounting expenses for network and subcontracting firms, for example, may be preferable to not knowing the cost of each phase of production when everything is done in house. A question remains, however, about how well such networks absorb radical innovations.

The Cluster Strategy

56. Related to the network strategy, SMEs can opt to enhance their competitiveness in global markets by participating in localised geographic clusters. In a clustering strategy, firms take advantage of linkages with other enterprises afforded by geographic proximity, in order to better access new ideas and knowledge. This strategy may be especially important in young industries or industries where strategic knowledge is tacit.

57. The importance of knowledge spill-overs in spurring innovation undisputed. However, Krugman (1991) and others argue that such knowledge externalities are so important that there is no compelling reason for geographic boundaries – such as city limits, state lines, or national borders -- to block the spatial extent of the spillover. It may seem paradoxical to claim that geography matters for innovative activity in a world of E-mail, fax machines, and cyberspace, where the cost of communications has plummeted. But there is an important distinction to be made between knowledge and information. *Information*, such as the price of gold on the New York Stock Exchange or the value of the Yen in London, can be easily codified and has a singular meaning and interpretation. By contrast, *knowledge* is vague, difficult to codify and often only serendipitously recognised. While the marginal cost of transmitting information across geographic space has been drastically reduced with the telecommunications revolution, the marginal cost of transmitting knowledge, and especially tacit knowledge, actually rises with distance.

58. Von Hipple (1994) demonstrates that high context, uncertain knowledge, or what he terms sticky knowledge, is best transmitted in face-to-face interactions and through frequent and repeated contact. Geographic proximity matters in transmitting sticky knowledge. Tacit knowledge is inherently non-rival in nature, and knowledge developed for a particular application can have economic value in very different applications. As Glaeser et. al. observed, “intellectual breakthroughs must cross hallways and streets more easily than oceans and continents.”.

59. An emerging economics literature demonstrates that knowledge spillovers are indeed geographically constrained. Data constraints can be overcome to study the extent of knowledge spillovers and their link to the geography of innovative activity using proxies like patenting activity, patent citations, or new product introductions. For example, Jaffe, Trajtenberg and Henderson (1993) found that patent

citations tend to occur more frequently within the state in which they were patented than outside of that state. Relatedly, Audretsch and Feldman (1996) found that the propensity of innovative activity to cluster geographically tends to be greater in industries where new economic knowledge plays a more important role. Prevenzer (1997) and Zucker, Darby and Armstrong (1994) show that in biotechnology, which is an industry based almost exclusively on new knowledge, firms tend to cluster together in just a handful of locations. In this latter case geographic proximity is clearly related to the role played by the scientists who transfer new economic knowledge from universities to firms.

60. The relative importance of proximity, and therefore the tendency of firms to spatially cluster, is shaped by the stage of the industry life cycle. In theory, knowledge spillovers and the propensity for innovative activity to cluster spatially will be the greatest in industries where tacit knowledge plays an important role. The role of tacit knowledge in generating innovative activity is presumably the greatest during the early stages of the industry life cycle, before product standards have been established and a dominant design has emerged. Audretsch and Feldman (1996) classify 210 industries into four different stages of the life cycle. The results provide considerable evidence suggesting that the propensity for innovative activity to spatially cluster is shaped by the stage of the industry life cycle. On the one hand, new economic knowledge embodied in skilled workers tends to raise the propensity for innovative activity to spatially cluster throughout all phases of the industry life cycle. On the other hand, certain other sources of new economic knowledge, such as university research tend to elevate the propensity for innovative activity to cluster during the introduction stage of the life cycle, but not during the growth or decline of an industry.

61. The importance of local clusters is evident from the Italian experience. Clusters of firms have experienced high levels of investment into process technologies, particularly in manufacturing automation, NC, CAD-CAM, and related technologies. According to several surveys of the Italian clusters, they facilitated the diffusion of new technologies through:

- Imitation of innovators by followers, which is facilitated by the observing technology adoption and by access to facilities.
- Positive word-of-mouth, which occurs more rapidly in a social community of entrepreneurs.
- Spillover effects, which are made easier by the mobility of workers and technicians, the activity of technical consultants, and commercial activity of capital equipment suppliers.

interaction with equipment manufacturers, which is intense, repeated and socially embedded, allowing for the development of technical reputation, trust, and the willingness to experiment new technologies.

The Foreign Direct Investment Strategy

62. There is considerable evidence that the trans-national economic activities of SMEs have been increasing over time. Not only has the absolute value of foreign direct investment activities by small and medium-sized enterprises increased over time, but so has their share of the total foreign direct investment, at least in several countries including Italy, the Netherlands and Japan.

63. The effectiveness of a foreign direct investment strategy for enhancing SME competitiveness is shaped by three fundamental sets of factors. The first is that the enterprise must have an endowment of capabilities in foreign markets that are superior to those of firms located in other countries. Such firm-specific assets, which can be called *ownership advantages*, are principally are intangible assets like proprietary knowledge or a position of market leadership or human capital. The second factor is that the benefits accruing to the SME for exploiting its firm-specific ownership advantages must exceed those it

would gain if it chose to sell or license them to foreign firms instead. Benefits could include gaining a larger share of the target market, risk diversification, or access to vital information about potential inputs or market opportunities. These benefits from the extending the enterprise's activities abroad must exceed the benefits expected from externalising its property rights through other mechanisms such as licensing, management contracts, franchises, technical services agreements, turnkey projects, and subcontracts. Finally, the third set of factors are those which make production abroad advantageous. There must be some factor inputs (including natural resources) found outside of the home country that provide an advantage to production abroad, since otherwise it would be simpler to export the product to foreign markets.

64. SMEs are confronted by a number of size inherent handicaps with respect to the conduct of trans-national activities. In particular, SMEs are clearly disadvantaged by scale economies and other size related ownership-specific advantages. Similarly, they may have more difficulty obtaining inputs on favoured terms. And all of the advantages bestowed upon subsidiary and branch establishments of incumbent corporations, such as access to administrative, managerial, R&D, and marketing capacity, are less evident for SMEs than for their larger counterparts. However, the benefits of expanding their markets, being exposed to different consumer demands, networking with foreign collaborators, and above all accessing novel sources of knowledge, clearly makes FDI an important element of the panoply of strategies open to SMEs who want to remain innovative in a global economy.

Policy implications : Broadening Government Support and Coping with the Diversity of Needs

65. Globalisation has clearly shifted the comparative advantage of OECD countries away from traditional inputs of production – land, labour, capital – and toward knowledge. As this shift has become better understood, public policy has responded in two fundamental ways. First, there has been a move away from the traditional triad policy instruments whose ultimate purpose is to constrain the freedom of firms to contract. More specifically, regulatory policy, competition antitrust policy, and the public ownership of business are on the decline. As long as the major issue was restraining the market power of large corporations, this policy triad was sensible. However, the waves of deregulation and privatisation throughout the OECD are a sign of the revolution of this approach to industrial policy.

66. Instead, governments are now increasingly concerned with the creation and commercialisation of knowledge. Examples of this new policy approach include measures to encourage R&D investment, venture capital creation, and the rapid establishment of start-up firms. In many OECD countries improvements can be made to the financial sector in order to create the large and liquid risk capital markets so important to new firm creation. The institutional conditions of greatest note are low taxation on capital gains; the existence of large institutional investors who are allowed to invest in non-quoted companies; professional risk evaluators for new technologies and new business; and rapid access to secondary markets.

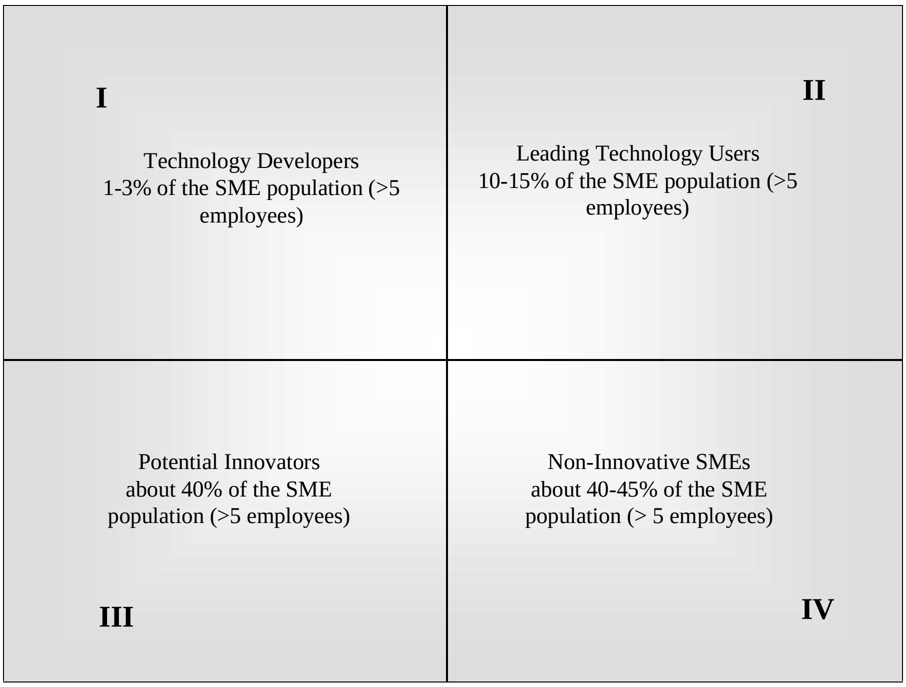
67. As for SME specific measures, a great emphasis is now placed on promoting investments in innovation. The most radical shift in SME policy over the last fifteen years has been the transition from a policy of protecting firms faced with size inherent scale disadvantages, to a policy of promoting new firm start-ups and the viability of SMEs involved in the commercialisation of knowledge. The shift in policy focus to knowledge-based SMEs is noticeable across the OECD.

68. Despite the fact that globalisation reduces the degrees of freedom governments have in their policy responses, they can still play an important role in encouraging SMEs to innovate and meet the globalisation challenge more effectively. One way they do so is by increasing the amount of capital available for access to or investment in innovation and new firm creation. Perhaps best known is the Small Business Innovation Research (SBIR) programme in the United States. In the 1980s the US Congress mandated that each major research agency allocate about 4% of its research budget to funding innovative

small firms. By the end of the 1990s, the SBIR programmes accounted for about 60% of all public SME financing programmes, and taken together the *public* SME finance is about two-thirds as large as private venture capital. Thus the government has a strong impact on innovative SMEs. Significantly, the SBIR and most public programmes fund early stage research, a stage which is generally ignored by private venture capital. The benefits of this programme include the launch of new companies; better survival and growth rates for recipient firms compared to other start-ups; a shift in many recipient research careers from academia to entrepreneurship; and demonstration effects which encourage entrepreneurship. A similar commitment to increased funding for SME research can be found across the OECD, at regional, national, and supra-national levels of government.

69. However, lead technology developers make up less than 5% of the total SME population (See Figure 1). The challenge for governments is to help the other 95% of SMEs remain globally competitive by becoming more knowledge based. Yet, for the most part, governments are not organised to do so. Most countries, in fact, co-ordinate their R&D support using a technology or sector focus, with sectoral programmes (e.g., agriculture, industrial production, health) or technology specific programmes (biotechnology, new materials, IT). A very small part of the national research budgets (usually less than 5%) are reserved for SME-specific programmes. This means that SMEs compete against larger firms for funding in traditional R&D programmes. Governments should consider amending their R&D and SME policies in order to broaden the population of small and medium size enterprises who can benefit from innovation programmes.

Figure 1 : Two-dimensional plot of SMEs according to their innovative capacity



Source: Clarysse and Duchêne, 2000.

70. Both technology developers and technology users who have a sufficient R&D capacity are able to successfully apply for R&D-grants or subsidies under the traditional technology policy structures. A recent study conducted by the European Commission shows that, on average 33% of the participating SMEs in the fourth framework programme are technology developers, 31% are leading technology users with

sufficient R&D capacity[16]. If we exclude the CRAFT projects from the analysis,[17] 43% of the SMEs that participate in the Framework Programme are technology developers and 32% are leading technology developers with sufficient R&D capacity.

71. Leading technology users who do not have sufficient internal R&D capacity and technology followers, on the other hand, experience huge difficulties in applying for R&D grants. They rarely participate in traditional R&D projects. Leading technology users without a sufficient internal R&D capacity are often too small in scale to apply for grants. Technology followers on the other hand, do not even have the "innovation capacity" to recognise the commercial potential in new technologies and innovations. For these SMEs, it is not the financing of R&D activities that is the problem, but simply the ability to access technological knowledge. Traditional EC R&D grants reach only SMEs who are technology developers and those lead technology users with an internal R&D capacity. Most national R&D programmes do not aim at stimulating R&D collaboration, which means they probably reach an even smaller share of domestic SME technology developers. Furthermore the technology developers that participate in the European Commission Framework Programme tend to be subcontracting consulting organisations that perform development or engineering activities for larger enterprises. In most national technology programmes, technical consultants are frequently not permitted to participate as contractors, so this category of SME is often excluded national R&D grant programmes, further limiting the number of SMEs who can access government innovation programmes.

72. The remainder of this section discusses who participates in government innovation programmes based on an EC study. It outlines the innovation needs of three categories of SMEs: (1) technology developers, (2) lead technology users, and (3) technology followers with a potential for innovative activity. And it suggests improvements in government strategies to encourage more innovation in the entire population of SMEs.

The Needs of Technology Developers – Looking Beyond Seed Capital

73. Several studies have shown that public funding in the form of R&D grants plays a decisive role as seed financing for high tech and potentially high growth SMEs. According to Mustar (1997), about 70% of the French new technology based firms have benefited from public R&D grants distributed by ANVAR. Clarysse and Degroof (2000) found that 50% of the Belgian spin-offs had received at least one R&D grant since inception. It is worth mentioning that R&D grants are often considered by these start-up ompanies as cheap sources of seed capital and the sums received can total several million Euros in their start up stage.

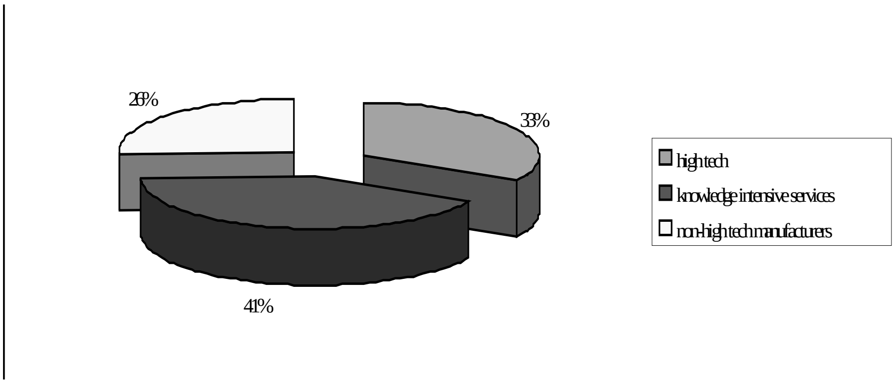
74. Public R&D grants are important for a particular type of SME, as is clear when one looks at the SME participants in the Fourth Framework Programme of the European Commission. A recent European Commission survey (CEC, 1998) concluded that 98% of the SMEs participating in their collaborative RTD

[16] A postal survey was conducted among the 4000 SMEs that obtained a contract under the 4th Framework Programme in 1995-1996. The results are based on the responses of 1314 SMEs (30% response rate).

[17] CRAFT is a Co-operative Research Action For Technology oriented towards SMEs. The ***CRAFT*** scheme is aimed primarily at SMEs with limited or no R&D resources of their own. It provides financial support to groups of industrial companies, in particular SMEs, which face a common industrial or technological research need. ***CRAFT*** enables these SMEs to come together and to contract a third party (a research centre, university or company) to carry out R&D on their behalf. The ***CRAFT*** scheme has a budget of approximately ECU 57 million. (9% of the BRITE/EURAM II budget). Projects should have a maximum duration of 2 years and maximum total costs of ECU 1 million. Up to 50% of the costs are funded by the Commission. The balance must be provided by the SMEs, which may provide in-kind contributions or find additional industrial funding sources.

projects were either "technology developers" or "leading technology users." [18] Clarysse, Removille, and Muldur (1999) further explored the profile of these enterprises and found that 41% of these SMEs were service organisations (engineering companies, consulting companies); 33% were new technology based firms (in micro-electronics, IT, new materials or biotechnology); and 26% were leading technology users with an R&D capacity (often from traditional industries such as textiles, construction, and agriculture). (See Figure 2.)

Figure 2 : Participation of SMEs in the Fourth Framework Programme (excluding CRAFT + Exploratory Awards)



Source: Clarysse and Duchêne, 2000.

75. The SMEs participating in the Fourth Framework Programme are not representative of the total population of European SMEs. However, they *are* a representative sample of all SMEs getting EU funding. Table 2 describes their characteristics in greater detail.

Table 2 : Different types of SMEs in the Fourth Framework Programme

	Technology Developers		**Leading Technology Users**
	New Technology Based Firms	*Service organisations*	
Firm age	11	15	40
Firm size (employees)	47	43	73
R&D budget as % of turnover	21,7%	32,1%	10,9%
Growth during 1996-1999 (in terms of employees)	89%	46%	17,9%
R&D grants, as % of R&D budget[19]	11%	27,6%	16,8%

Source: Clarysse and Duchêne, 2000.

18 The CEC includes in its Framework Programme collaborative projects in which partners from different member states are required to collaborate in order to put in a proposal.

19 To calculate this ratio, we took the actual amount of money received by the company in the fourth framework programme. Then, we divided the amount by the number of years that covered the duration of the project and finally, we divided this by the company R&D budget.

76. We can conclude from Table 3 that the leading technology users who participate in Commission's Fourth Framework Programme are significantly older and larger than are the technology developers, be they new technology based firms or service organisations. In addition, leading technology users are significantly less R&D intensive. It is interesting that the consulting organisations are quite R&D intensive. These organisations are typically technical consultants and count R&D as a "non-core" activity. Looking at firm growth rates during the three-year period preceding the study, there were statistically significant differences between the three categories of firms. The new technology based firms had significantly higher growth rates than the service oriented technology developers or the leading technology users. However, technology developers are also the companies least dependent on the R&D grants to finance their technological developments. Only 11% of their R&D budget comes from European grants, which is significantly lower than the 16.8% reported by the leading technology users. New technology based firms could rely in the future on other private sources of finance for their R&D activities. Governments should encourage such a trend by improving the conditions for private capital investments to support SME innovation.

77. Public R&D grants were the only viable source of seed capital in Europe during most of the eighties and early nineties, a period during which high tech, high growth companies were very scarce. Since then a number of conditions have changed. First, the amount of European seed capital from non-government sources has been rising constantly. Although these sources of seed capital are much more expensive than a public R&D grant or loan (EVCA figures show that seed capital funds earned in 1998 about 36% on their invested capital per annum), they are easily obtained and can be spent with great flexibility (within the limits of a business plan). Furthermore, venture capitalists speak the language of the entrepreneur, in contrast with the bureaucrats disbursing public funds.

78. The second change has been that the technological orientation of the new wave of high tech start-ups is no longer weighted toward biotechnology and electronics. Close to 80% of all new technology start-ups are in information technologies -- software, Internet, and telecommunication software. Because these firms are more focused on providing a service and face much shorter development times, these companies do not follow a clear technological innovation trajectory and are thus not easy to evaluate by public granting institutions. Clarysse and Degroof (2000) find in their spin-off study that new firms in the IT sector believe that public R&D grants are not geared at them because they do not do enough technology development.

79. Nevertheless, the new technology developers remain an attractive population of SMEs: they have the potential for rapid growth; are at the leading edge of technological development; and employ a highly educated labour force. Public agencies have strong incentives to adapt their strategies to meet the needs of this population of SMEs. New policy approaches include:

1. *Closer collaboration with the Venture Capital industry.* In those countries such as Belgium, France, and Germany where venture capital markets are booming, there should be better collaboration between the R&D granting institutions and the private or semi-public VC industry. A number of public granting organisations (e.g., ANVAR in France and SENTER in the Netherlands) are indeed co-operating with the local venture capital industry, and they do so for two main reasons. First, public R&D grants and loans are complementary to private seed capital. An increasing number of VC funds require that start-ups apply for public grants first in order to develop a technology or prototype, and only later resort to private capital sources for business development needs. Second, public agencies employ a large numbers of engineers (or have a network of technical experts) who are trained to perform technological due diligence. The venture capitalists are more specialised in assessing business potential than technological viability. An exchange of information between the two types of organisation (business plans vs. audit reports) is mutually beneficial. Furthermore this

collaboration simplifies the administrative burden of the technology developer by allowing for the exchange of audit reports, business plan evaluations, firm cross-references, and experience.

2. *Grants for business plan development and for non-technical activities.* Since R&D grants are project based and often oriented towards the development of new technologies, SMEs often encounter difficulties putting together successful proposals. The latest generations of new technology based firms are especially in need of business support – such as business plan development, venture coaching -- rather than simply public financing (Chiesa & Piccaluga, 2000). Public bodies might provide support for such non-technical aspects of the innovation process, as SENTER and Enterprise Ireland have begun to do.

3. Pure equity financing. Some countries go one step further in their strategy adjustment towards technology developers: they offer seed capital and take equity stakes in new companies, (Enterprise Ireland). Equity finance mechanism can complement classic public R&D grants and business development grants.

Box 1. Closing the Funding Gap – The Role of Technological Rating

Financial institutions, as well as government bodies, have difficulty assessing the risk-profit trade offs of innovative ventures. Uncertainties about the technical feasibility, the time period of development, the total financing needed, and the probability of commercialisation and possible market size, make financial institutions hesitate before funding venture projects.

To overcome the information gap between entrepreneurs and financing bodies – and thus increase the external sources of financing for SMEs -- governments can encourage the development of technological rating instruments and organisations. Technological rating is a wholistic method for evaluating the technological feasibility, commercial risk, and managerial capacity of an SME and its proposed innovative project. Technological rating organisations can be public or private bodies, and serve a bridging role between the financial sector and potential innovators.

80. In conclusion, public R&D grants have been and continue to be of remarkable importance to technology developers. For some technology developers, especially during start-up, R&D budgets can be larger than company turnover or even starting capital. These companies have substantial financial expenses if they are to bring innovative products to the market. However, private alternatives to public financing are increasingly available and governments should consider collaborating with the private sector in the evaluation of technology based firms, including to ensure the rapid diffusion of expertise in technological rating that would help reduce the uncertainty that limits private sector investments in high risk innovation projects (Box 1). They may also want to consider subsidising programmes that help SMEs cope with the business challenge of applying for private funding.

Table 3: Characteristics of European Public Technology Policy Institutions

Country	CEC	Belgium (Flanders)	Netherlands	France	England	Ireland
Main Public R&D institute[20]	Framework Programme (°1984[21])	IWT (°1991)	SENTER (°1988)	ANVAR (°1979)	DTI	Enterprise Ireland (°1998)
Yearly Budget	3,75 billion (5de FP: 1998-2002)	156 million (1999)	590 million (1998)	213 million (1998)[22]	5,2 billion (1999)	203 million (1999)
Number of Firms as Client[23]	?	1050 (1998)	?	2.048 firms (1998)		?
% SMEs[24] **among clients**	18,3% (4th FP: 1994-1998) [25]	24% (1998)[26]	?	76%[27]		?
Specific SME friendly grants?	Yes	Yes	Yes	Yes	Yes	Yes
Equity financing[28]	No	No	No	No	Yes	Yes
Non-financial support for SMEs?	No	No	No	No	Yes	Yes

Source: Clarysse and Duchêne, 2000.

The Added Value of R&D for Lead Technology Users

81. As is shown in Table 3, leading technology users are important participants in public R&D programmes. A recent econometric (Meeusen, 2000), shows that R&D grants given by the Flemish IWT to the Flemish SMEs significantly affect the R&D expenditures of these SMEs in subsequent years, a result which is in contrast with large companies for whom R&D grants have no effect on the size of the R&D

20 These are the most important technology policy institutions in each country. In France there are two other important actors which are not mentioned in this table (Ministry of Education and Research, Ministry of Industry); in England DTI is responsible for many other domains besides the pure technology policy. Therefore comparability of the data in this table is not fully guaranteed.

21 Year founded.

22 Not included: budget of Ministry of Education and Research, Ministry of Industry.

23 Firms that applied for support AND effectively received it.

24 Definition of European Commission: <250 employees and independent.

25 Including CRAFT-projects (14,5% without CRAFT-projects).

26 In respect of Belgian (Flemish) definition of the SME: less than 200 employees.

27 SME according to the Anvar-classification: less than 50 employees.

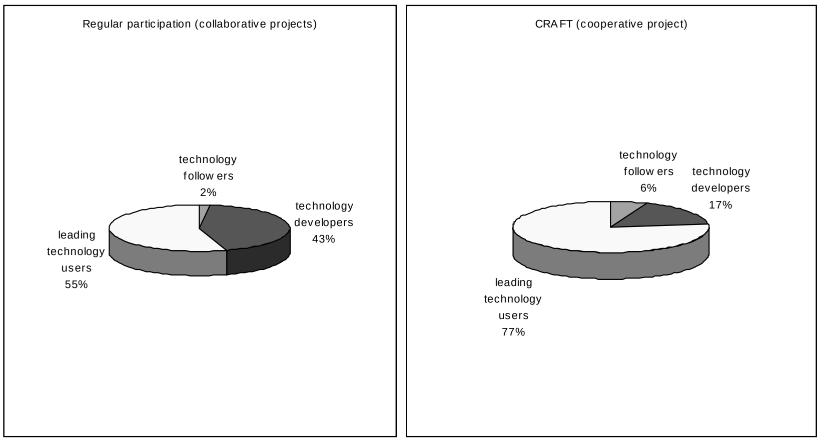
28 Only related to equity financing organised by the main R&D granting institute!

budget in the following years. R&D grants seem to have substantial *additivity* to the size of the R&D investments of leading technology users (i.e. they do not substitute the existing R&D budgets).

82. Although technology users are a large subgroup in the SME population, their profile is much less articulated and understood than that of the technology developers. A typical leading technology user could be an SME active in the textiles industry for whom R&D mainly consist of looking for and testing new materials that are more washable, softer, etc. A typical such SME might have three employees out of thirty who spend part of their time on R&D activities, in other words looking for and testing new materials. Such an SME has less than one full time equivalent performing R&D, with minimal administrative support. For this reason, the SME does not have the necessary critical mass to develop a research proposal and apply for an R&D grant.

83. Leading technology users, according to an EC audit, are most likely to participate in programmes designed *specifically* for SMEs. One example is the CRAFT Co-operative Project programme whose special characteristics are that: it has less administrative requirements, provides more assistance to SMEs, and requires much less technical novelty from participating firms than is typical of general R&D programmes. National innovation programmes targeted at SMEs are also characterised by lower entry barriers in terms of administrative requirements, technical novelty, or time between submission and acceptance (Keeble and Lawson, 1997; Autio, 1997). In addition, most SME customised programmes fund smaller projects. As illustrated by Figure 3, which compares SME participation rates in regular collaborative R&D projects *versus* CRAFT, technology followers find these lower requirements appealing.

Figure 3 : Leading Technology Users' participation in CRAFT and regular R&D programmes



Source: Clarysse and Duchêne based on SME Co-ordination unit, DG XII (1998).

84. Government innovation programmes that are customised to SMEs needs attract leading technology users first because the programmes fund smaller projects. The financial sums involved are often too small to satisfy the needs of technology developers who have substantial R&D budgets. Since the projects are about technology development, they are of no interest to technology followers who typically have no R&D department or innovation activities and thus cannot participate in technical programmes. By design, SME-customised innovation programmes tend to reach leading technology users.

85. Since public R&D grants to leading technology users actually encourages these firms to subsequently increase their R&D expenditures, this sub-population of SMEs is a politically attractive target group. Lead technology users tend to see public R&D grants as a way to professionalise their R&D efforts, look for new technical opportunities, and explore new production methods. Public financial support is

necessary since these firms do not have the cash flow or capital to initiate R&D activities, but are able to continue and even increase such activities once they are running.

86. In order to target leading technology users, programme procedures should be simple since they do not have the organisational slack to devote resources to search for funding or put together applications. Furthermore, governments should promote the “single point of sale” concept. SMEs should not be tasked with finding *which* public programme best suits their needs. It should be possible for them to submit a single application and have a public body or agency be responsible for finding the appropriate financing mechanism. The CRAFT scheme in the Fourth Framework Programme, for example, did not succeed as expected because for an SME to discover its existence among all the possible other schemes was akin to looking for a needle in a hay stack.

Making Innovation Possible for Technology Followers

87. The innovation programmes described so far cater to the requirements of less than a quarter of the total SME population. Is it pointless to target the SMEs who fall into the technology follower population? Not at all. Several European examples demonstrate that almost half of these firms could benefit from better innovation policies.

88. The economic argument justifying technology policies and R&D support is that enterprises under-invest in R&D because they cannot fully capture the rents of their efforts. Governments should intervene to correct for this market failure and provide a greater financial incentive for private investments in R&D. The problem is that technology followers do not *under-invest* in R&D, they simply *do not* invest. However, this does not mean that they cannot be innovative nor that they cannot make use of technological developments from outside.

89. According to a Dutch study conducted by EIM, about 40% of the Dutch SMEs can be considered as potential innovators. Such firms operate in a variety of manufacturing and service sectors and share an openness to new products. Clarysse and Uytterhaegen (1999) found Flemish SMEs who were also potential innovators in that they often consciously introduced different organisational innovations. Furthermore, technological developments were often used as a tool to implement organisational innovations rather than an end in themselves. Examples include a producer of “environment-friendly” products who used e-commerce as a new way to promote his products; a machine construction company implementing new IT-driven project management tools to improve efficiency and exports; a design company which used new developments in light bulb technology to create a new lighting concept for well-known hotels.

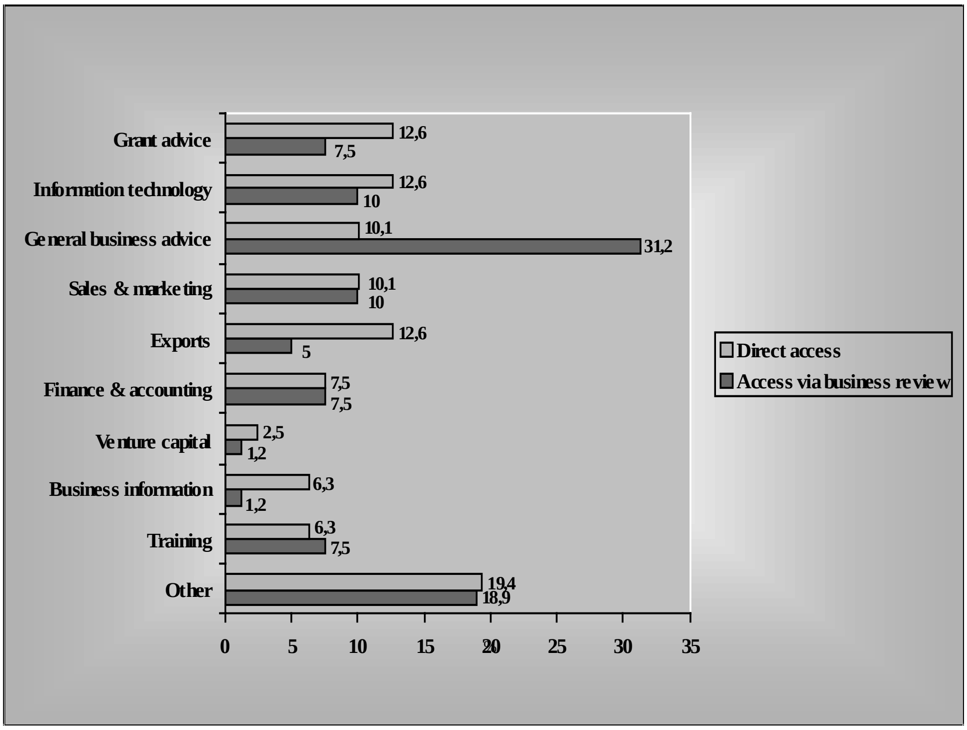
90. The major problems for these potential innovators is knowing where to find new technologies, recognising the commercial potential for their company, and being able to adopt the technology to their particular situation. The decisions they must make in evaluating new technologies are multi-faceted and complex from a business perspective. SMEs must assess costs and benefits, the complementarity with existing technologies the company uses, and the fit of new technologies in their product portfolio. Technical experts in public research bodies or institutions are not of much assistance as their speciality is high end, complex technologies, to solve a unidimensional problems. Because the mind set separating the world of technical experts and that of entrepreneurs is so large, there need to be mechanisms in place which help narrow the gap. In some countries such as the US, technical and business consultants are important carriers of innovation to SMEs but their role in Europe remains limited so far.

91. Innovation policy does not consist of the correcting a market imperfection due to under-investment in R&D. Instead, public support should be used to “legitimise” the role of innovation agents which are actively involved in closing the above knowledge gap. The legitimising role consists of making

the SMEs familiar with third party expert advice that can leverage the level of their internal operations. Since the government is not adjusting for market imperfections, but legitimising, government involvement in this sort of innovation policy could have a limited time horizon. Once legitimisation has occurred, the government might leave such brokering or agent activities to the private sector. Several countries have indeed recently initiated such innovation policies for SMEs, including Ireland, Scotland, Denmark, and, at a more regional level, Germany have developed networks of innovation agents. The two of the most advanced examples are Business Links in the United Kingdom and Syntens Innovation Networks in the Netherlands.

92. The most important aspect of forging an innovation policy for "potentially innovative SMEs" is maintaining a *missionary* ideal. Innovation policy should be based on the assumption that SMEs do not want to be helped and often do not know how they can use the knowledge presented to them. Syntens and Business Link are missionaries, in that their role is to spend time with the customer SME. The innovation agency must help the SME define his problem and find a solution to the problem. Ernst and Young describes the types of consultancy services innovation agencies can offer, using Business Links as an example (Figure 4).

Figure 4: Types of services, including consultancy that are offered by Business Links



Source: Ernst & Young Evaluation Report (1996), as cited in Clarysse and Duchêne, 2000.

93. The activities of a "missionary" innovation agency can be roughly divided into six categories.

– *Customised advice including strategic consulting.* This activity most resembles professional consulting. The project is usually short term, not in excess of 16 hours, and involves *scanning* certain operational problems where there are strategic gaps. The firms that approach Business Link on their own ask, in 25% of the cases, advice concerning R&D grants and export grants.

Two thirds of the SMEs *do not* contact Business Links themselves and are pro-actively contacted. For these firms Business Links eventually offers a wide range of consulting activities, including sales and marketing advice.

- *Brokering and networking.* Innovation agents play an important role in networking (the category "other" in Figure 4). When a problem or a need becomes clear, after a scan for example, and is well beyond the capabilities of the innovation agency, the SME receives a list of professional service providers that can help. Often, the innovation advisor is asked to evaluate the costs or demands of the service provider as a relatively neutral third party. SMEs rely on the innovation agency for a third opinion on many relational issues.

- *Grant advice.* Innovation networks usually do not distribute grants (although Syntens in the Netherlands has a small fund that can be used to hire skilled persons). However, they can play an important role in actively promoting existing grant schemes, be they R&D related or not.

- *Scans and business reviews.* Scans are instruments that help the innovation advisors learn about the structural characteristics of the SME in order to advise management about the strengths and weaknesses of a company and its possible needs. Examples include: the quick scan (a scan of one and a half an hour, which situates the company in a product/market); the core competencies scan (which lasts 3 hours and is used to define SME core competencies); the network scan (which lasts 3 hours and identifies the network needs); and the innovation scan (to measure the innovative capability of the SME). In England such business reviews are the main vehicle by which one meets new SME-customers.

- *Organisation of workshops*. Workshops about specific technologies or organisational changes are given regionally (see "training" in figure 4). Workshops are oriented to restricted target group of SME who are already regular customers.

- *Distribution of business information.* All sorts of information dissemination is possible through web sites, production of newsletters, even regional television.

94. In sum, the potential innovators in the group of technology followers are a large and important target for novel technology or innovation policies. However their needs are very different from the previous two categories of SMEs. In particular:

- They need non-financial innovation advice, such as scanning or consulting services.

- They need help recruiting university graduates and other skilled personnel.

- They need to be made aware of new ideas and technologies.

- They need better incentives for collaboration with local technical centres or technical colleges

95. Because of their very different needs, the public R&D granting institutions are not well positioned to provide these services. First, these bodies often operate at a national or regional level and innovation services are most effective when decentralised and local. Second, these institutions are bureaucratic and technical, and their competence lies in the technical evaluation of proposals. The SMEs need innovation advisors, not administrators. Third, because the SME innovation problems are complex and multi-dimensional, services should be offered by organisations that combine business and technical

skills. The current innovation policy landscape is too fragmented in most countries to offer such combined services—public bodies either offer pure technical advice or just financial help.

Conclusions

96. In most countries, technology programmes are organised by technology domain or sector. They do not target different sub-populations of companies. Nevertheless, in the last five years an increasing number of countries have introduced special SME programmes. Only a few countries however make a clear distinction between different kinds of SMEs.

97. Technology developers, and especially the new technology based firms are the subgroup of SMEs that have benefited longest from public R&D support schemes. Because their focus is on developing leading edge technologies, they are best able to respond to government R&D programmes. In addition, a lack of early stage seed capital meant that they needed the government for project financing. But the emergence of private capital sources reduced the necessity of public grants for this group. Since R&D granting institution have accumulated a huge amount of experience in dealing with technology start-ups, their knowledge can be used in complement the expertise of venture capitalists. In some countries, public seed capital organisations are merging or collaborating with the institutions that administered R&D grants. Governments should actively encourage the collaboration between these R&D granting institutes and private or semi-public seed capital industries. In some countries, if no seed capital is available, its development should be stimulated.

98. The second group, the leading technology users, has benefited the most from the recent SME-friendly programmes introduced by many OECD countries. These firms perform some development and design work, often have an absorptive capacity that recognises and adopts new developments, but they lack the size to be very active in R&D. In particular, their lack of critical mass prohibits them from applying for R&D grants. Steps by governments to lower entry barriers to public R&D programmes by requiring less administration and less technological novelty are extremely welcome developments. Indeed programme customised to the needs of such SMEs have been unveiled in many OECD countries. However, it is not enough to simply offer such novel programmes might (the CRAFT case being an example of their moderate success). Since SMEs have difficulty finding the most appropriate public programme given the complex web of public initiatives, governments try to develop “single point of sales” entries for SMEs. The public granting institution should be responsible for choosing among its programmes the optimal mechanisms or financial resources in order to meet the SME’s stated need. A single point of sales strategy would have the added value of facilitating public relations with SMEs.

99. The third group are the potentially innovative, traditional, non-R&D-intensive SMEs. They are not using technology as a source of innovation, but as an enabling mechanism. R&D grants are of little use to these companies. Instead, 75% of them need advice on non-financial matters. Among the 25% that spontaneously ask for grant information, only half are explicitly interested in R&D grants. The main objective for these companies is to close the knowledge gap between the vast amount of technical and engineering knowledge available (from public research institutes, customers, suppliers) and their own day-to-day business activities. Meeting this need requires a very different set of skills than those which administrators in public R&D granting institutions have. Innovation agencies are better suited to respond to the problems technology-follower SMEs face.

100. The innovation agent model of the Netherlands and the United Kingdom are good examples of one solution, but in both countries the model is still too young to be fully evaluated. They have a lot of problems: the regional innovation centres offer services of varying quality; governments are unsure how long or even whether they should be subsidised; co-operation between advisors who have a technical

versus a business background is not straightforward. Policies targeted to SMEs will require a lot of experimentation and learning before they succeed. Also there are no recipes for success that will be valid for all countries and regions.

101. Nevertheless, in most countries the present landscape is too fragmented and innovation consultancies are not available to assess the multi-dimensional problems characteristic of most SMEs. Keeping in mind that different SMEs will require different policy instruments, one of the major improvements would be policies that target technology-follower SMEs. One option for governments would be the marriage of the technical centres with economic advisory agencies that specialise in SMEs. Furthermore, although advice should be organised at a decentralised and local level, governments should have a well-functioning central agency that evaluates and offers help to the regional innovation agencies in order to mitigate against variations in quality. Maybe R&D-granting institutions can play a role as central co-ordination agencies and knowledge platforms.

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