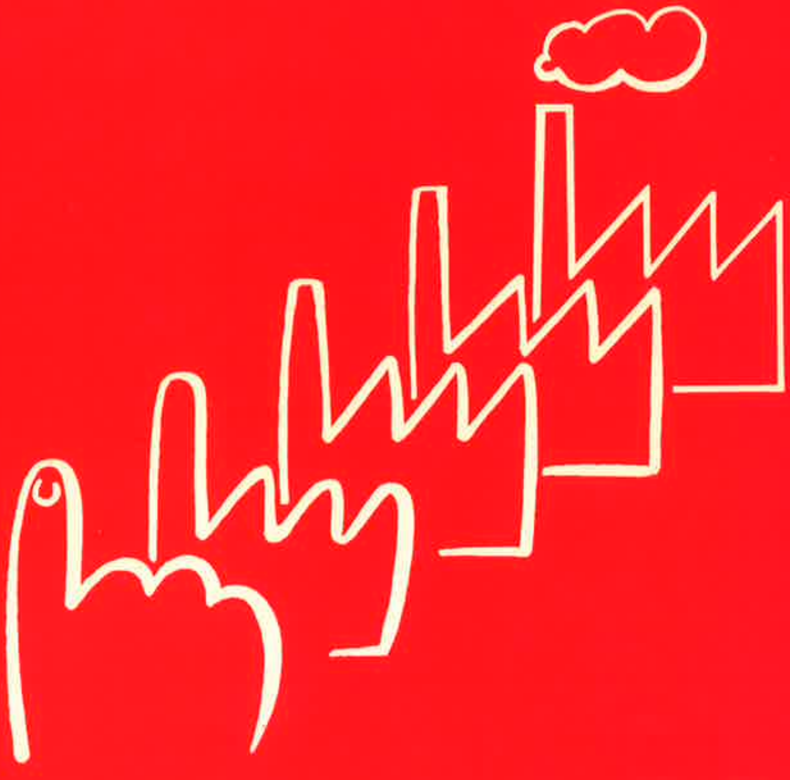
INNOVATION AND THE SMALL AND MEDIUM SIZED FIRM

Roy Rothwell and Walter Zegveld



INNOVATION AND THE SMALL AND MEDIUM-SIZED FIRM: Their Role in Employment and in Economic Change

This book describes the role and problems of small and medium sized firms (SMEs) in innovation. It argues that SMEs play an especially important role during the early phases of major new technologies in pushing forward their development and commercialization on a broad front.

Technology-based new SMEs are shown to be a potent force for economic recovery at the national level, as well as for regional industrial regeneration. The key role of SMEs — and especially of young, technology-based SMEs — in the creation of new employment is also emphasized.

The book argues that governments must move from funding only R&D to the wider aspects of supporting 'innovation'. This requires a broader perspective on the role of new products in the economy and on government policy towards enhancing the position of SMEs who are often the leading innovators. A comprehensive inventory is given of government measures to stimulate innovation in SMEs in the countries of Europe, the USA, Canada and Japan.

Contents:

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CONTENTS

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1 INTRODUCTION

Today, as in the past, support for small firms comes from many and diverse quarters. Among the objectives pursued in support of small industrial firms it is preferable to distinguish between general economic, political, social and cultural objectives on the one hand, and the specific objectives of national scientific and technological policy, on the other.

Any assessment of the importance of small firms within the industrial and social structure of societies, and the need to strengthen their productivity, will lead to the establishment of measures aimed at improving the position of these firms as utilizers of upgraded technologies. National scientific and technological policy, on the other hand, will tend to be mainly interested in the small innovative or new technology-based firm within the fluid, high growth, science-based industrial branches, from which radical new technologies might emerge.

Among the *general policy reasons* for supporting small firms are:

- The distribution of economic power through a system of small firms leads to a more favourable distribution of power in society in general. The existence of small firms has positive effects on political and social stability. Conversely it is often held that excessive concentration of economic power has unfavourable and destabilizing effects in the long run.
- A high degree of market concentration leads to economic inefficiency. This argument can be interpreted in the static sense, meaning that monopoly power leads to misallocation of resources. It can also be interpreted in terms of dynamic efficiency. In this sense it can be argued that monopoly power leads to complacency, which in turn leads to a slower rate of technological progress than would otherwise be possible. It is hence argued that small firms are a necessary competitive spur to existing oligopolists; that their existence is a proof that market entry is possible; and hence that the presence of small firms itself guarantees a certain market dynamism.
- A more widely held position considers that small firms are a necessary complement, rather than an alternative, to the economies of scale

offered by large firms. In addition to filling markets considered as too small by their larger partners, there is the issue of large–small relationships. For example, large scale modern process industries cannot effectively survive without an appropriate 'hinterland' of small, user-oriented firms and an industrial fabric marked by a wide network of subcontracting relations between large companies and small firms.

– Another argument is that small firms should be valued more highly than their quantitative share of the market suggests, because their diversified products are better able to cater to the individual tastes of consumers at a time when the dominant technological regime, dictated by economies of scale, tends towards a culturally impoverishing reduction in variety. There are two aspects to this argument: first, it is argued that if the external costs to society as a whole of economies of scale are brought into the economic equation, it becomes clear that small firms should receive some sort of protection from governments. Although in the area of manufacturing there is leeway for letting the quality of the small firms products speak for itself, governments may help by improving the flow of information to consumers, and modify a situation too highly dominated by the marketing budgets available to large scale producers.

The second aspect of this argument is the claim that after more than two decades of technological development characterized by the exploitation of economies of scale, certain limits have now been reached in this respect, both in the area of consumer acceptance of mass goods that offer little potential for individual expression, and in that of technical opportunities for development. A change of technological regime from low cost production and economies of scale to quality and individuality will in itself offer good opportunities to the small industrial firm.

– Small firms are sometimes seen as a buffer to sharp fluctuations in employment. Several reports have been brought out recently, all showing the remarkable resistance that small- and medium-sized enterprises have in the current economic climate with respect to employment, although precise statistical data on this matter are still rather incomplete. We discuss this issue in some detail in chapter 7.

A related case is sometimes made for the superiority of small local firms over manufacturing divisions or branches of large firms, with headquarters elsewhere, in providing employment stability in under-industrialized regions. This position is based on the disappointing results of regional industrialization policies in a number of countries. While providing short-term relief of local unemployment when enticed by government subsidies to locate in the regions, branch manufacturing plants were hardest hit when the recession came. It is also argued by some experts that governments would do better to support local small firms because of their more even balance between direct and indirect personnel and their firmer commitment to local interests. The issue of small firms and regional development is discussed in chapter 8.

- The quality of working life in small firms is sometimes said to have certain advantages over work in large firms. Relations are less impersonal, and there is more direct relationship between an individual's effort and the final output of the firm. Evidence from the UK suggests that small firms are less 'strike-prone' than their larger counterparts. On the other hand, employees of large firms are often better organized to protect their economic position, safety rules may be better adhered to, and more emphasis may be placed on participation programmes. It is clear that as yet no broad or general statements can be made on the quality of working life in small industrial firms as compared to large ones. Further analysis of existing data on job satisfaction, turnover, and health, as well as new empirical data, would be necessary before any firm conclusions could be drawn on this issue.
- Small- and medium-sized manufacturing firms are to a large extent working in areas of traditional industry that are gradually being placed at a competitive level with industries in developing countries. First this has been true in such sectors as textiles, shoes, etc., but now also the metal fabricating sectors are being increasingly challenged. There seems ample opportunity, however, to make industries in developed nations more efficient from a standpoint of both current and future production.

Technology policy arguments for supporting smaller firms have to deal with the position of small industrial firms with regard to technological change, this being a many faceted subject. Depending on the type of small firms one may have in mind, emphasis may be put on the role of the small firm either as a source of technical innovation or, on the contrary, as a barrier to the widest possible diffusion of the 'best' technical practices. Research has shown that a significant number of basic innovations have originated in small firms and that small firms often play an important role, especially in the United States, in industries characterized by a particularly high rate of growth and technological change. On the other hand, many traditional industrial sectors with low growth rates are also characterized by large numbers of small firms, unable to generate enough income to finance not only the R & D that might lead to higher productivity and new products, but also the new investments which would incorporate upgraded technologies.

The arguments below will be principally those related to the role of the small firm as a source of new ideas and innovations. These arguments may be listed as follows:

- Technological change is best promoted in a system that utilizes the potential symbiosis between small and large firms, which derives from the fact that the former are particularly adept at radical innovations, while only the latter have sufficient resources for successful large scale development.
- Research results showing the ability of small firms to produce radical innovations tend to suggest that in certain industry sectors, small firms are responsible for a disproportionately large share of radical innovations. If these findings are placed alongside Schumpeter's analysis that entrepreneurial activity is responsible for creating the new techno-economic combinations on which economic upswing is based, governments should be especially concerned at present about the vigour of small firms. From this standpoint the smaller firms can be viewed as a genetic pool from which the successful techno-economic combinations of the future will be selected.
- The place attributed to the contribution of small firms in technological innovation is brought out by a model developed by W. J. Abernathy and J. M. Utterbach of the Center for Policy Alternatives at MIT. This model distinguishes between product lines which are in a very rapid or 'fluid' stage of development, and more mature sectors characterized by 'specific' manufacturing technology. Firms in the fluid state are characterized by high rates of product innovation, competition on the basis of performance maximization rather than price, small size, loose entrepreneurial organization and the use of general purpose manufacturing technology with relatively skilled labour.

  By contrast, as a product line matures, individual products become more and more standardized, almost a commodity; process change tends to predominate over product change; competition is primarily on the basis of cost minimization and minor product differentiation, the firm becomes much larger, more hierarchical with strong division along function lines, production equipment becomes highly specialized, and product changes become more and more difficult. For mature firms working in oligopolistic markets, innovations consist primarily of small incremental process improvements.

  An industrial structure marked by the presence of small, high technology firms may thus be considered to be simultaneously the cause and the consequence of product lines in the fluid stages of development. In chapter 3 we discuss the general issue of the role of small firms in economic development and present our own rather simplified 'model' of patterns of post-war industrial evolution.

– Calculations made by the National Science Foundation on the basis of its industrial R & D statistics suggest that, in terms of innovation measured against dollar expenditure on R & D, small firms have had a much higher – although falling – performance than their larger counterparts. The arguments concerning the contribution of small firms to innovation seem, however, to require quite definitively a branch level analysis. It is only in certain industrial branches that small innovative firms are in a position to contribute to technological development and to enter and stay in production without meeting too drastically high barriers to entry. Detailed evidence concerning the role of small firms in invention and innovation is provided in chapter 4.

In studying aspects of government policy for supporting smaller firms and considering the fast growing interest of governments in the problems and welfare of small- and medium-sized manufacturing enterprises, the authors experienced a great deal of difficulty in obtaining reliable and detailed data concerning these firms and their role in the various economies.

Much of the data and the analyses that were available were several years out of date. Further, while it was possible to describe qualitatively government measures designed to assist small firms in the innovation process, in most cases quantitative data were unobtainable. If governments, who would take the welfare of smaller firms seriously, are to formulate useful and adequate policy measures, then these measures ought to be based on detailed knowledge of smaller firms, their particular problems and their present and future role in the economy. Future measures should also be based firmly on an assessment of the efficiency of current and past measures. There exists, however, a marked paucity of impact studies. This is an area in which governments should usefully promote careful and systematic research.

Because of very different historical backgrounds and cultural traditions in different geographical regions, government policies that find successful application in one country might not meet with the same success elsewhere. Great care must be taken, therefore, by governments wishing to import policy measures that have proved successful in other geographic areas (see chapter 2).

While smaller firms enjoy a number of advantages over large firms in the innovation process, e.g. flexibility, dynamic response to market shifts, entrepreneurial environment, they also suffer from a number of inherent disadvantages. These disadvantages are mainly related to scale, i.e. lack of cash, lack of qualified manpower resources, inability to obtain economies of scale in production and distribution, including exports. This lack of resources means that they are less able to accommodate the high risks involved in innovating than their larger counterparts. Government policies towards small firms should therefore be aimed at helping them overcome the disadvantages of small scale and at reducing the technical, financial and market risks in developing innovative, specialist products, in which area their comparative advantage over large firms generally lies.

By definition innovation involves both technical novelty and utility. Every innovation must therefore rest on a new combination of a technical feasibility and an economic demand. To realize this combination some commitment of funds is needed, sometimes small, more often quite substantial. It is the unique characteristic of the innovator (whether he be an individual or an organization) that he (or it) is able to recognize both the technical feasibility and the demand, and is also willing to make an investment decision upon this insight.

While the above follows directly from a broad definition of innovation using the concepts of technical novelty and utility, it is also the basis for a more detailed analysis of the innovation process and thereby of government measures to promote innovation. Even a preliminary analysis would tend to confirm the proposition that it is of little use to set up government programmes in isolation. Specifically it can be said that most programmes only provide one of the three inputs defined in the above triple input model of technological innovation. Success will then depend on whether the other two inputs are available and whether the management of the firm is adequate from a standpoint of innovation.

It is the explicit position of the authors that, because of the aggravated position of small firms and the role they have to play, governments should and could take a new *active* stand towards assisting these firms in their efforts to innovate. The main emphasis should therefore be put on the overall innovation process, and measures should be based on a thorough analysis of problems encountered by these firms.

It is the purpose of this book to describe the role of small- and medium-sized manufacturing firms in the economy, in innovation and with respect to employment. Government policies that would foster the role of small- and medium-sized firms towards innovation are described in detail in chapter 9, as well as recent trends in relevant government policy formulation, and some past limitations of policy. Medium-sized and small firms can best be regarded as essential elements in an innovative world. Government policies towards fostering this group of firms can be regarded as strengthening a social–cultural movement well under way.

The performance of small firms in innovation and in employment generation (growth) is, of course, closely bound to the characteristics of small firm managers, and the successful creation of new small firms in the modern world is very much a function of the entrepreneurial abilities of their founders. The issue of technological entrepreneurship is discussed in chapter 5.

While smaller firms are undoubtedly extremely valuable to social, economic and technological policy for the reasons discussed above, it is highly doubtful whether, alone, they are sufficient to act as the dynamo of the next economic upswing; existing large firms also have a crucial role to play. It is a fact that a number of large firms, especially in the United States, have sought internal revitalization and regeneration by attempting to adopt small firm-type structures, either totally within themselves, or in close association with themselves. In chapter 6 we discuss in some detail the important issue of internal entrepreneurships in large firms.

Finally, we come to the definitional question of precisely what we mean by a 'small firm'. National definitions vary enormously, ranging from employment of below twenty to employment of below 500 or even 1,000. Further, even within a country, the definition can vary from sector to sector or with the requirements of one policy initiative and the next. In terms of turnover it can also vary from $1 million or less to $5 million or more. In this book we have decided to use the term 'small- and medium-sized firms' (SMEs) to refer to the 'smaller' firm and, generally speaking, an SME is a firm with a total employment of less than 500 persons. Throughout the book we deal solely with firms in the *manufacturing sector*.

2 SMALL- AND MEDIUM-SIZED FIRMS IN DIFFERENT CULTURES

Throughout this book we are interested in SMEs primarily from the point of view of their technical progressiveness in traditional industries, and their innovativeness in the new technology-based industries, and hence their ability to survive and prosper in an increasingly competitive world. The role of SMEs in the economy varies nationally, as does their contribution to technological innovation.

A country's propensity for technological innovation is determined not only by the economic conditions prevailing there, and its R and D infrastructure, but also by society's attitudes towards innovation. Cultural differences between different countries and regions will, therefore, strongly affect the rate and direction of technical change as well as government policies set up to foster innovation. In particular the emphasis on firms of different sizes will vary from country to country. We shall briefly characterize here the three major regions of the industrial world, namely Europe, the United States of America and Japan.

Europe may be characterized as an area hidebound by tradition and very much anchored to its past. It has a marked tradition for scientific research and has been, and is, highly inventive. This has led to a situation of a high incidence of 'technology-push' innovations. Europe has generally adopted an attitude of self-protection rather than of aggressive risk-taking. It lacks the liveliness and the spirit and the entrepreneurial drive necessary for the vigorous commercial exploitation of inventions. Lack of both geographical and social mobility in Europe has not been conducive to innovation. In Europe, governments and industry have not always worked together well, and there has been a lack of co-ordination between the two. Government intervention is largely seen as 'interference', this being especially the case with the normally fiercely independent managers of SMEs.

The US is a young, lively and enterprising country, where there has always been fundamental optimism and confidence in the future, both being a spur to innovation. There is a widely held and continued belief in the superiority of the market economy. Innovations in the US have been largely of the 'market-pull' type. The legislative and educational systems in the US are such as to favour and enhance the value of entrepreneurial drive. Geographic and social mobility have favoured innovation. The major commitment in the US towards world leadership in strategic areas (e.g. aerospace, computers) has induced further innovation in other sectors of the economy and has also led to the emergence of many entrepreneurial technology-based small firms. In the US to 'make a buck' is respectable, and part of the Great American Dream. This has created a climate conducive to individual endeavour and entrepreneurship.

In Japan industry, commerce and government work in close co-ordination, and relationships between all three are good. In fact, the propensities of the Japanese to co-ordinate their efforts at all levels and in all quarters, and also to protect and nurture their domestic industry, represent two very strong cultural themes. Legislation in Japan is designed to protect and favour domestic industry, thus creating a climate of prosperity that is conducive to innovation. The domestic market is used as a foundation on which to build productive expansion and operates on the market-pull mechanism for innovation. Japan practices an explicit strategy towards foreign markets; its industrial system works in a co-ordinated manner. High firm loyalty and group decision-making, including good internal communication, have been favourable to innovation in Japan, particularly to organizational and production efficiency-type innovations. The very high average level of education in Japan, together with a marked national *esprit de corps*, have made a valuable input to its innovative capabilities.

From the above it is clear that different cultural traditions in the three regions have affected their attitudes towards innovation. Government policies, therefore, that might find successful application in one country, might not meet with the same success elsewhere. For example, policies for co-ordinated and collaborative exporting will find favour in Japan, where there is a strong tradition of co-ordinated industrial trading, but not in the US where free and individual competition is the dominant mode of trading. This means that great care must be taken by governments wishing to import policy measures that have proved successful in other geographic areas.

Because of the different cultural traditions, small- and medium-sized manufacturing enterprises (SMEs) and their problems are also viewed differently in different countries. In order to understand the different roles of small firms in the economies of these three areas, as well as to appreciate fully the nature of the policy measures adopted by different governments to try to solve these problems, it is helpful at the outset to establish, where possible, the various historical backgrounds and cultural frameworks which guided the formulation of these policies, and the role played by SMEs in different national economies. It seems also useful to consider the historical data showing the relative efficiencies of small and large firms in a number of countries. This may throw some light on different government attitudes adopted towards SMEs in these countries (Takizawa, 1974; Colombo, 1977).

Any definition of efficiency should take into account the input to a process as well as the output. The following tables (2.1, 2.2, and 2.3), unfortunately, contain measures of output only. In interpreting them it should be borne in mind that the capital intensity of large firms (i.e. the input) is generally higher than that of small- and medium-sized firms. Data are available only for the UK, the US and Japan. They do, however, highlight some marked differences, especially between the UK and the US on the one hand, and Japan on the other.

Table 2.1 shows the size differential in net per capita output in UK manufacturing industry in 1963. The data show an increase in output with increasing firm size.

Table 2.1 Size differential in net per capita output in the UK

Size of establishment (employees)	Net per capita output £	Index of output
25–99	1,174	81.5
100–199	1,212	84.1
200 or more	1,441	100.0

Source: Report on the Census of Production, 1963.

Table 2.2 shows the index size differential in annual value added per employee in US manufacturing industry in 1963 and 1967. Establishments with more than 1,000 employees are taken as an index of one hundred. Once again the data generally indicate an increase in efficiency with increasing firm size, although between 1963 and 1967 there was some convergence.

Table 2.3 shows the indexed size differential in annual value added per employee in Japanese manufacturing industry in 1958. As well as showing a marked increase in efficiency with size, it indicates a considerably larger size differential for Japan than that indicated for either the US or the UK.

Table 2.2 Size differential in per capita value added in the US

		Firm size by number of employees					
		1–19	20–99	100–249	250–499	500–999	More than 1,000
Value added per	1963	67.1	68.2	73.7	77.8	87.8	100.0
employee	1967	77.5	72.7	77.2	82.3	89.6	100.0

Source: Takizawa, 1974.

Table 2.3 Size differential in per capita value added in Japan

	Firm size by number of employees				
	1–9	10–99	100–499	500–999	1,000 or more
Annual value added per employee, 1958	27	39.3	67.1	76.5	100.0

Source: Takizawa, 1974.

Historical Perspectives

As we shall show later, the role of SMEs in the national economy (share in output, share in employment) varies a great deal between countries. This has partly coloured governments' attitudes, and is partly the result of government policies, towards assisting SMEs.

Thus, government measures to assist innovation in SMEs did not occur spontaneously, but have evolved over a period of years. In order to understand fully why particular measures have been adopted in different countries, it is necessary to discuss the historical and cultural factors that have affected their formulation. The following section describes the very different historical perspective pertaining to the UK, the US and Japan in order to underline this point.

The United Kingdom

The following historical factors have, until recently, coloured the UK government's attitude towards small business:

- Small businesses in the UK were traditionally thought of as being economically inefficient, and there has been a strong recognition of the economically efficient aspects of large scale. Despite this, the differentials in size between large and small businesses, in terms of productivity, wages and profitability, have been relatively small and not as great as, for example, in Japan. Also, small firms have played a progressively smaller role in the UK economy. For example, establishments with less than 200 employees accounted for 44 per cent of all establishments in 1924 and for 42 per cent of net output. The corresponding figures for 1968 are 29 per cent and 25 per cent respectively. Hence there has been scant recognition of small business problems as being important problems of the national economy.
- Early in the twentieth century the concentration of economic power was not as evident in the UK as in the US. Later on, nationalization and government control were promoted. The 'evils of monopoly' were therefore of no great concern in the UK, and there was consequently no driving force for protecting and nurturing small firms as a countervailing force against monopoly.

The United States of America

The argument in favour of protection of, and assistance for, small business in the US has been very strong. In the US, although it has been recognized that small businesses have earned relatively low profits, have been plagued by financial problems and have suffered from business instability, it has not been thought that all small businesses have been economically inefficient. The belief has prevailed that small business are the true motive force pushing economic growth and supporting the free enterprise system. This belief has its roots in the process of concentration of economic power in the US since the last quarter of the nineteenth century and the perception of the evils which this process of monopoly caused. This belief has been strengthened following the increase in concentration which occurred after the Great Depression.

Post-war attitudes toward the role of small businesses in the US can be summed up from the following extract of the Small Business Act of 1953:

The essence of the American economic system of private enterprise is

> free competition. Only through full and free competition can free markets, free entry into business, and opportunities for the expression and growth of personal initiative and individual judgement be assured. The preservation and expansion of such competition is basic, not only to the economic well-being, but to the security of this nation. Such security and well-being cannot be realized unless the actual and potential capacity of small business is encouraged and developed. It is the declared policy of the Congress that the Government should aid, counsel, assist and protect insofar as is possible the interests of small business concerns in order to preserve free competitive enterprise, to insure that a fair proportion of the total purchases and contracts for supplies and services for the Government be placed with small business enterprise, and to maintain and strengthen the overall economy of the nation.

Hence the US Government has expressed a strong interest in the welfare of small firms and the creation of new small firms. Small business problems have been seen as important problems of the national economy.

Differences in attitude towards small businesses between the US and the UK might account for the fact that while the proportion of the number of employees in manufacturing establishments employing less than one hundred fell in the US by only 3 per cent between 1935 and 1963 (from 30 per cent to 27 per cent), it fell by 10 per cent in the UK during the same period (from 30 per cent to 20 per cent). Certainly, in contrast to the UK where policies for supporting and protecting small firms were seldom adopted, they did become adopted with some vigour in the US.

Japan

Industrialization in Japan did not begin until the latter half of the nineteenth century, when it was compelled to industrialize rapidly despite the lack of both accumulated capital and natural resources. The situation could be summarized as one in which there was lack of capital, but surplus of labour. Under these circumstances industrialization was deliberately planned and enforced through government initiative rather than by the initiative of private capitalists as in the UK.

During the latter quarter of the nineteenth century Japan's economy was dominated by traditional industries and by a large number of small firms. Government policies relating to these industries were limited to encouraging the formation of trade associations with the aim of preventing destructive competition and to discourage the production of inferior goods. By 1891 there were already some 770 trade associations in Japan.

Large firms in Japan enjoyed high prosperity during World War I but, like companies elsewhere, suffered during the depression. As a result of this, they began to rationalize and, since capital was short and high-efficiency modern machinery was expensive, they began to utilize small contractors on a large scale to exploit their low wage levels. Partly as a result of this, there was an increase in the number of small firms in the between-the-wars years. Government policy to SMEs during this period concentrated on providing financial support and the promotion of co-operative activities. Widespread subcontracting to small firms became, and remains, a very marked feature of the Japanese industrial scene.

Following World War II, when large firms in Japan were in a state of disorganization, there was once again a growth in the number of small firms. Today SMEs in Japan exist in large numbers and play a vital role in the economy. They are mainly subcontractors to large firms, and rather closely bound to them. Because of their large numbers, their relatively low level of productivity and technology, and their relatively poor working conditions and instability, problems of SMEs in Japan are seen as important problems of the national economy.

In contrast to the US, therefore, where small businesses present a problem to the national economy because their numbers are low, in the sense that more are thought desirable to stimulate and protect free competition as the cornerstone of the free enterprise system, in Japan small business problems are important because their numbers are relatively very high.

Turning again to Europe, there is little doubt that during the past decade interest in the welfare of SMEs has increased, and much of this interest is centred around the belief in the ability of SMEs to generate innovations and employment. This is made clear in a recent publication by the Commission of the European Communities (European File 18/80, December 1980):

> One thing is sure, however: by virtue of their number and their diversity, by their penetration in all sectors of the production and marketing of goods, through their contribution to employment and to the prosperity of particular regions, these companies are an essential component of the industrial structure of our countries. In addition, they are also a source of dynamism and vitality for the whole of the economy: this mass of constantly emerging and developing companies form a sort of matrix for our economic system; the small- and medium-sized companies constitute, in particular, a vehicle which is particularly well

adapted to the development and diffusion of innovation throughout the whole industrial fabric.

Such attitudes have become rather widespread and we can state with some certainty that interest in the general well-being of SMEs is on the increase throughout the developed market economies. This had led in turn to a significant increase in the number of measures taken by governments to assist SMEs, and in particular to assist their innovatory endeavours.

We have pointed to the role that different cultural and historical factors have played in determining national attitudes towards SMEs. This is clearly reflected in individual governments' innovation policies. Thus, in the US, where new, technology-based small firms have played a particularly important role in the economy, government policy is biased towards the provision of venture capital and the creation of a climate conducive to risk-taking and entrepreneurship. In West Germany where SMEs have played an especially significant role in the highly successful engineering industries, emphasis is placed on infrastructural support, and the West German government's policy has been biased towards the managerial and technological regeneration of existing small firms rather than towards the generation of new, technology-based firms. In Japan, with its preponderance of many small supplier firms, government policy is based on infrastructural support and incentives towards collaborative efforts in production, distribution, purchasing and R & D. Government policy towards SMEs in a number of countries will be discussed in detail later in this book.

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3 SMEs: THEIR ROLE IN THE ECONOMY AND IN ECONOMIC DEVELOPMENT

1. Introduction

In chapter 2 we discussed the relative roles SMEs have historically played in the US, Japan and Western Europe, and described a number of differences between the three areas in terms of differing attitudes and cultural characteristics and traditions. In this chapter we shall discuss briefly the role SMEs currently play in a number of major market economies. We shall then present a model of industrial evolution that appears to have been characteristic of a number of the 'new' post-war industries and in which small firms – or at least small units – have played a key initiating role.

2. SMEs' role in the national economy

Table 3.1 shows the shares in national employment, added value, turnover and investment in SMEs (employment below 500) in the US, Japan and six countries in Europe during 1977/78. While, since the US data refer to 'establishments' rather than independent firms, it is difficult to make across-the-board comparisons, nevertheless a number of interesting differences do appear. For example, it is apparent that SMEs play a significantly greater than average role in the Japanese economy in terms of their share in employment and in the Dutch economy in terms of their share in both output and employment.

If we take the ratio 'share in turnover' to 'share in employment' as, at least, a rough proxy for the efficiency of SMEs in each country relative to that of their larger counterparts, then, again, marked national differences emerge (see also chapter 2). These are illustrated in Table 3.2. In only Italy and the Netherlands is the relative efficiency of SMEs greater than unity.

These differences will, of course, depend to some extent on national industrial specialization and the role SMEs play in different sectors of industry. Table 3.3 presents data for France and the Netherlands on the relative roles and efficiences of SMEs in five industries and on these five

Table 3.1 SMEs (employment <500); their relative share of employment, added value, turnover and investment for some OECD member countries[1]

%	US[2]	Japan	Finland	France	FDR	Italy	Netherlands	UK
Employment	58.2	54.4	–	40.3	43.4	43.7	56	44.3
Added value	51.4	44.1	35.7	–	31.4	49.2	–	40.7
Turnover	52.6	41.2	30.8	30.9	31.9	50.5	60.7	41.1
Investment	–	33.9	–	21.2	32.9	43.5	–	–

[1] Data refer to the last available year (1977–8).
[2] Corresponds to establishments.
Source: OECD, DSTI/SPR/80. 15, Paris, May 1980.

Table 3.2 Relative efficiency of SMEs defined by the ratio: share in turnover/share in employment

	Japan	France	FDR	Italy	Netherlands	UK
Turnover/ Employment	0.76	0.77	0.74	1.16	1.08	0.93

industries' share in total manufacturing employment and output. It shows that, except for the chemical industry, SMEs' share in output and employment is rather different in the different sectors in the two countries. It also illustrates how the five sectors, taken together, play a very different role in the countries' economies. Clearly, then, comparison between countries on the role of SMEs should (data permitting) take into account differences in national industrial structures.

Moving back to more aggregate data, Table 3.4 shows the changes over time in share in manufacturing output taken by SMEs in a number of countries. With the exception of Japan, it can be seen that SMEs' (or, in some instances, 'small firms') share in output has declined to a greater or lesser degree. Alongside this decline in the role of small firms in most advanced market economies has been a progressive increase in industrial concentration, and an ever-increasing share in industrial output has generally been taken by the few largest firms in each sector.

This does not necessarily imply, however, ever-increasing plant size. Prais (1976) has demonstrated for the UK, for example, that although the share of the one hundred largest *enterprises* in manufacturing net output

Table 3.3 SMEs' share in employment and output/employment ratio for five industries in France (1976) and the Netherlands (1974). The five industries' share in total manufacturing output and employment and relative industrial efficiency

	SMEs' share in sectoral			Sector's share in total manufacturing		Relative industrial efficiency (share in O/P, share in employ.)
	Employ.	Output	O/P emp.	Employ.	Output	
France (1976)						
Textiles	38.3	34.4	0.90	14.0	9.6	0.67
Transport articles	10.9	8.9	0.82	12.9	14.2	1.10
Building materials	43.6	42.1	0.96	3.9	3.7	0.95
Wood and furniture	63.2	59.4	0.95	4.5	3.5	0.78
Chemical industry	35.5	35.8	1.01	15.1	20.6	1.36
				50.4	51.6	Average 1.02
Netherlands (1974)						
Textiles	62.1	64.3	1.04	5.4	3.4	0.63
Transport articles	36.1	33.8	0.94	8.2	5.5	0.67
Building materials	75.6	78.2	1.03	4.0	2.4	0.60
Wood and furniture	90.7	90.2	0.99	3.9	2.2	0.56
Chemical industry	36.5	36.3	0.99	9.3	14.9	1.60
				30.8	28.4	Average 0.92

and employment roughly doubled between the 1930s and the late 1960s, the share of the one hundred largest *plants* did not increase. This suggests that although average plant sizes have increased, the largest firms have increased their share in activity by building and acquiring more plants or establishments to a much greater extent than they have by concentrating in larger units. Therefore production economies of scale do not fully explain the decline in importance of small firms in the UK. Bannock (1976) suggests that this is due to a large extent to distortions in the UK capital market, notably that the features of the taxation system have tended to channel savings into large financial institutions which invest mainly in large firms, and only rarely in small ones.

The sectoral data for France in Table 3.4 are interesting. They show that while SMEs' share in output declined markedly in the more traditional industries (e.g. textiles, wood and furniture) during the 1970s, their share in the modern industries has been more stable (electronics) or has even increased (chemicals).

Table 3.4 SMEs: their changing share in manufacturing output in four countries

France (<500 employees			
Share in manufacturing O/P		1970	1976
Chemicals		22.4%	35.8%
Electronics		20.6%	20.5%
Textiles		57.2%	34.4%
Wood and furniture		66.7%	59.4%
Paper, cardboard and graphics		50.7%	37.6%
All manufacturing		29.6%	28.3%
Japan (<300 employees)			
Share in manufacturing O/P		1962	1974
		48.4%	51.3%
Ireland (<£200,000 turnover)		1963	1968
Share in manufacturing O/P		21.2%	13.6%
UK (<200 employees)	1951	1968	1976
Share in manufacturing O/P	32%	25%	Approx. 18%

Japan is probably a special case. SMEs in Japan play an especially important role as suppliers to the major corporations, to which they are often contractually rather strongly bound. They interact closely with their large customers on such issues as component and assembly design and quality control. While it is mainly the larger Japanese companies that are internationally known, SMEs are playing an increasing part in exports, accounting for 31 per cent of direct exports in 1975.

SMEs have also played a key role in the post-war development of the West German manufacturing industry, especially in the all-important mechanical engineering sector. They have played a crucial part in creating a stable social and economic climate and have been central to the post-war economic recovery plans of the West German government.

Thus, measuring the importance of SMEs merely through their share in output and employment cannot capture their true national significance. In some countries they play an important role in both political, and regional employment, stability. They meet consumer needs in relatively small market niches, often based on local demand specification variations. In particular, they form a hinterland of specialist suppliers to major corporations, manufacturing a very wide range of components and sub-assemblies, as well as sophisticated, custom-built devices. In other words, SMEs form a crucial part of the overall, national industrial infrastructure operating in areas in which scale economies (production and marketing) are not especially important, capital intensity is often low, skill intensity often high and demand often highly specific and variable. Finally, as the next section suggests, SMEs might play a crucial role in national economic development.

3. SMEs and economic development

It is becoming increasingly evident that the causes of, and possible solutions to, the current world economic crisis are being interpreted very differently by different governments. The UK government, and latterly the government of the US, have adopted a neo-classical 'monetarist' interpretation, seeking to solve their countries' economic problems, initially at least, through controlling the money supply, curbing public expenditure and thus – or so the theory goes – reducing inflation, from which great benefits in international competitiveness, increased investment in manufacturing, and generally increased industrial activity are expected to follow. Technological change is not stated explicitly to play a central role in this process, except in so far that increasing unemployment better enables firms to seek improved productivities through the purchase of modern, labour-saving equipment.

Several other countries in contrast – notably Japan and France – appear to have accepted that certain structural changes have taken place in the world economy which must be mirrored by changes in their own economies. These structural changes imply a policy of choice concerning the exploitation of new technologies and the development of particular product groups (Rothwell and Zegveld, 1981). Thus, policies in these countries involve, centrally, the role of technological change.

The distinction made above between neo-classical interpretations of economic growth, and the technology-based structural interpretations, are important in the context of this book since the latter – as will be discussed below – might imply an especially important role for small firms, specifically new technology-based small firms. Before describing a technology-led model of industrial evaluation, it is first worthwhile briefly describing the structurally-based 'long wave' model of economic development, and the role of technological change in long wave formation.

Probably the earliest detailed formulation of long wave theory was that of a Russian economist, Kondratiev (1935) who, in the early twenties, analysed the development of long-term trends in selected economic indicators. He discovered a number of long waves in the world economy of between fifty and sixty years' duration. Kondratiev did not explicitly include the role of technical change in long wave formation, but he did suggest that when a major wave of expansion was under way, inventions that had remained dormant would find application.

The notion of long waves was later taken up by Schumpeter (1939), who ascribed a central role to technical change in long wave formation. He introduced the idea of *technological revolutions* as the driving force of the Kondratiev cycles, and pointed in particular to the role of steam power in the first Kondratiev (1818–42), railroads in the second (1843–97) and of electric power and the automobile in the third (1898 to about 1949). Schumpeter related these major changes primarily to bursts of innovative activity and entrepreneurship.

Kuznets (1954) later pointed out that there appears to be no special reason to expect that the intensity of entrepreneurial innovative activity will vary in long cycles, although he did accept the possibility of a bunching of innovations associated with new technologies and of investment activities associated with these bunches of innovations. Such innovations would need to be such, however, that their effects would permeate throughout the economic system and be far-reaching.

Freeman (1977), while basically supporting the Schumpeterian interpretation, has pointed to a number of snags – for example to the very different development in time of the automobile industries in America, Europe and Japan. He also pointed to the need for 'basic science' coupled to 'technical exploitation' followed by 'imaginative leaps' – all preceding the Kondratiev upswing. As Ray (1980) puts it:

> Schumpeter himself emphasised the view that whilst there *is* a relationship between innovation and economic development, it is a very complex one. One innovation is followed by another and the long chain eventually produces new products or processes which are again further developed and/or replaced. If the new product or process is important enough, it generates activity in many allied areas and cascades through the whole fabric of economic and social life.

Work on long wave formation today falls basically into two camps, the first emphasizing factors of demand, the second emphasizing factors of supply. It is probably true to say that researchers in the US generally fall into the former category and are looking at indicators of aggregate demand, notably demand for capital goods (Graham and Senge, 1980), while workers in Europe are focusing largely on the supply side, i.e. on the role of innovative push (Mensch, 1979). Even the former, however, acknowledges that the increased economic activity associated with the rapid re-equipment by industry creates the right climate for the exploitation and rapid diffusion of basic innovations that have remained 'dormant' during the recession/depression period. This, in turn, results in the growth of new industries which further increases the demand for physical capital, often of a new kind.

It would be out of place in this book to offer a detailed description and analysis of long wave formation, and a number of recent articles offer such an analysis in relation both to changing patterns of employment (Rothwell, 1981) and to economic development generally (Clark *et al.*, 1980). What is important is that even the demand-pull models acknowledge the importance of new and improved technology to the economic upswing. It seems most probable, moreover, that a range of factors, including new technological capability, needs to occur more or less simultaneously to create the right conditions for the economic recovery. This can be illustrated by consideration of the second and fourth 'Kondratievs'.*

Railways were developed in Britain at a time when she enjoyed a very large share of world trade and was opening up new and captive markets in the countries of an expanding Empire. Industrialization was proceeding apace, and much wealth was being generated. There was a pressing and growing need for an efficient and rapid transport system to carry raw materials from various parts of the country and from the seaports to the centres of production and back to the ports as finished goods. The need for rapid personal mobility of businessmen was also growing. The basic innovations necessary for the development of the railways (the steam engine, Stephenson's first locomotive in 1814) were in being. Cheap and mobile labour was available from Ireland in large quantities. There was thus a 'confluence' of factors – technological, economic, sociological and demographic – which, together, formed the basis of the second Kondratiev.

Similarly, the economic and political situation in Europe during the 1930s, and in particular the 1939–45 war, *forced* the rapid transformation of scientific and technological knowledge and inventions into practical innovations and spawned the modern industries – synthetic materials, petro-chemicals, pharmaceuticals, composite materials and electronics – during a relatively short period. This involved massive capital expenditure, mainly on the part of the governments, and the concentration of scientific

* The period of prosperity associated with the fourth Kondratiev is approximately 1949–68.

and technical manpower resources. The bunching of new industries formed the basis of the fourth Kondratiev. Again, the influence of a number of factors – including, centrally, new technological capabilities – was necessary before the economic upswing could take place.

Thus, it seems that while technology has played a central role in forcing the world economy out of its major periods of recession, it must be coupled with a great and widely diffused need(s), the availability of large volumes of capital and the presence of entrepreneurs – along with favourable social and political conditions – before commercialization, rapid business development and diffusion occur on a sufficiently large scale.

Industrial evolution during the post-war period and the role of technology*

Having described post-war structural changes in the relationship between manufacturing output and employment, and suggested the presence of long waves in world economic development of approximately fifty years' duration, we shall now attempt briefly to describe the pattern of evolution of industry during the past thirty years or so that will explain these changes. This has implications for current and future directions of investment in technology, and hence for both company and government policy.

The post-war era has been characterized by the rapid growth of 'new' industries based on new technological capabilities that emerged during the previous twenty years or so. These new industries – notably electronics, synthetic materials, petro-chemicals, agro-chemicals, semiconductors, composite materials and pharmaceuticals – generated new areas of technico-economic activity and the growth of new markets. Alongside this was the rapid growth in demand for capital equipment, often of a new kind. The wealth generated by the emergence of these new high technology industries caused an associated boom in demand for consumer durables resulting in the rapid growth of the automobile and consumer white goods industries.

Table 3.5 offers a simplified schema for the pattern of post-war industrial development.† During the early phases, production is initially undertaken in small and relatively inefficient units. Development emphasis is predominantly one of product change and the introduction of new products. At the same time market demand is expanding rapidly. The

* This section is taken from Rothwell (1981b).

† See also the technology-based model of product/process change in evolving production units suggested by Abernathy and Utterback (1976), and the detailed schema of Kondratiev wave formation described by Freeman (1977).

job-generating effects of expansionary investment outweighs the job-destroying effects of rationalization investment, and many new jobs are created.

As the industry gains production experience, and because of innovations by capital goods suppliers, manufacturing efficiency grows. Production units become larger, leading to increasing scale economies, and some mergers and take-overs occur. Organizational innovations take place. The industry enters a period of consolidation, and productivity increases rapidly. At the same time, market demand continues to expand at a high level. The job-generating effects of expansionary investment are roughly in balance with the job-destroying effects of rationalization investment, and manufacturing employment more or less stabilizes.

As the industry matures it becomes highly concentrated, with very large production units, and productivity reaches historically high levels. Markets increasingly become ones of replacement, and some market saturation takes place. Price becomes increasingly important in competition, especially for non-differentiated goods. Technological opportunities for major product innovations diminish, and the development effort becomes one of mainly process rationalization. The rate of productivity increase outstrips the rate of demand growth, and many jobs are lost.* (At the same time firms increasingly locate production in low labour cost areas, and further jobs are lost in the advanced nations.) Business confidence wanes. If this happens concurrently in a number of major industry sectors, then a recessionary trend becomes established.

The point is, there is evidence to suggest that a number of major industries have indeed reached a stage of market saturation (synthetic fibres, steel industry, petro-chemicals), and that in some areas in which post-war rates of growth have been very high, market expansion is small or nil, and markets are very much one of replacement (automobiles, consumer electronics, consumer white goods).

According to this interpretation, the major industries need to look to the rapid development of new markets (in, for example, the Third World) in order to expand output considerably, or for radical new developments

* The point is, it is not the rate of productivity growth *per se* that causes unemployment, but rather the mismatch between the rate of growth in demand and growth in productivity. Thus, between 1960 and 1973, when there was considerable expansion in world trade, the annual average percentage increase in manufacturing productivity for countries such as Japan, France, Canada, Italy, Germany, the US and the UK, taken together was 4.48: at the *same* time, unemployment in these countries was relatively low. Between 1973 and 1979, the average annual percentage increase in manufacturing productivity for the same countries was only 1.92, but this outstripped demand growth in a number of key areas: during this period, manufacturing unemployment in these countries generally increased.

Table 3.5 Model of post-war industrial evolution

1945 to approximately 1964 – dynamic growth phase

Emergence of new industries based largely on new technological opportunities.

Production initially in small units.

Emphasis on product change and the introduction of many new products.

Rapidly growing new markets.

Some market regeneration in traditional areas, e.g. textiles.

New employment generation (output growth greater than productivity growth).

Competitive emphasis is mainly on product availability and non-price factors.

Mid to late 1960s – consolidation phase

Increasing industrial concentration and growing static scale economies.

High dynamic economies.

Introduction of organizational innovations.

Increasing emphasis on process improvement.

Some major product changes, but based mainly on existing technology.

Rapid productivity growth.

Markets still growing rapidly.

Output growth and productivity growth in rough balance (manufacturing employment more or less stable).

Competitive emphasis still mainly on non-price factors.

Late 1960s to date: maturity and market saturation phase

Industry highly concentrated.

Very large production units, often vertically integrated.

Some product change, but emphasis predominantly on production process rationalization.

Increasing organizational rationalization, including foreign direct investment in areas of low labour cost.

Growing automaticity.

Stagnating and replacement markets.

Productivity growth greater than output (demand) growth.

Rapidly growing manufacturing unemployment.

Where products are little differentiated, the importance of price in competition is high.

Source: R. Rothwell (1981b).

to regenerate demand in existing markets. To some extent the electric light industry achieved a series of such partial reversals from a state of saturation with the introduction of the fluorescent lamp in 1938 and the halogen lamp in 1959 (Haustein, 1978). The development of a high-density electric cell might have the same effect in regenerating the automobile industry, as well as parts of the public transport sector.

An alternative – Schumpeterian – solution would be the generation of a whole *new* bunch of industries based on technologies currently in their infant stages. Possibilities already being mooted (and in some instances already the object of a great deal of technical development activity and some industrial exploitation) are:

– Bio-technology (biomass, single cell protein, bio-engineering)
– Energy-related technologies (heat pumps, solar energy systems)
– Electronic office equipment
– Advanced information technology
– Advanced medical electronics and new forms of implants
– Coal gasification and liquefaction
– Exploitation of ocean resources (the ocean bed, aquaculture)
– Robotics technology
– New agro-chemicals for the regeneration of marginal land

Not all these technologies will provide directly innovative opportunities for existing or new technology-based small firms (NTBFs). In the areas of coal gasification and the exploitation of ocean resources, for example, the capital costs will be sufficiently high to preclude the widespread participation of SMEs. On the other hand, many indirect opportunities might be generated for SMEs as suppliers of specialist components and sub-assemblies to major corporations operating in these areas.

In the area of biotechnology, on the other hand, evidence from the US suggests that NTBFs will enjoy many opportunities. The same can be said of the field of advanced medical technology; indeed, in medical instrumentation, SMEs have traditionally played an important role in innovation and market exploitation.

In other areas, e.g. heat pumps, SMEs might play a significant part in the early, fluid stages of industrial development as innovators. As the industry matures and production scale economics and distribution and service considerations become dominant, such firms will be compelled to grow rapidly or to be taken over by existing large corporations.

Finally, it must be stated here that the dramatic increases in oil prices that took place during the 1970s are not regarded as an insignificant factor in the current economic crisis, since they significantly reduced national purchasing power and hence aggregate demand, as well as contributing to increases in inflation. This situation has been further exacerbated as workers have fought to maintain real wage growth during a period of declining demand growth which has increased both inflation and manufacturing unemployment. Evidence suggests, however, that structural changes occurred *before* the 1973/74 oil crisis, which had the effect primarily of *accelerating* an already established trend (Rothwell and Zegveld, 1981).

The development of the semiconductor industry in the US

In the light of the above discussion of industrial evolution, in which new branches of industry grow based on the emergence of new technological opportunities which generate new areas of economic activity, and during which process, in the early phases, small firms (or units) play a key role, we shall now discuss briefly the emergence of the US semiconductor industry as an example of this process.

The beginnings of the semiconductor industry can be traced to the invention of the transistor effect in Bell Telephone Laboratories in 1947 by Bardeen and Brattain. Although their findings paved the way for the invention of the bipolar junction transistor, the real breakthrough came in 1952 when Shockley, the research team leader, described a field effect transistor with a central electrode consisting of a reverse-biased junction. Shockley subsequently left Bell Laboratories and several years later he established his own company in his native Palo Alto backed by finance from the Clevite Corporation. Shockley attracted a number of leading physicists and engineers into his company but, in 1957, eight of his brightest people left to form their own company. This marked the beginning of the rapid growth of new technology-based firms in the Palo Alto area which subsequently gave it its name of Silicon Valley. While a number of other centres of semiconductor production were emerging concurrently, notably at Dallas, Texas (Texas Instruments) and Phoenix, Arizona (Motorola), it is nevertheless true, as Mason (1979) states, that 'Silicon Valley has been exceptional in world terms in the amount of business generated and technological innovation which has occurred in such a concentrated area.'

The eight ex-Shockley workers succeeded in obtaining backing from the Fairchild Camera Corporation, which had been actively seeking diversification and, in September 1957, Fairchild Semiconductor was founded in Mountain View, California. In 1959, Fairchild Camera Corporation exercised an option to buy a majority interest in Fairchild

Semiconductor. The latter grew rapidly, from sales of $0.5 million in 1950, to $27 million in 1967, to $520 million in 1978.

During the next few years there was considerable spin-off from Fairchild Semiconductor of both people and technology, and many companies were formed by people formerly with, or associated with, Fairchild. This process has been described by Mason (1979):

> . . . The first spin-off was in 1959, when Baldwin, not from the original Shockley team, left Fairchild to form Rheem Semiconductor, collecting on the way people from Hughes Aircraft. In 1961, four of the originals left to form Amelco, and one of these, Hoerni, left in 1964 to form Union Carbide Electronics; moving on in 1967 to form Intersil. Of particular interest . . . was another event in 1961, when Signetics was formed. This was formed by four people, who were a significant part of the Fairchild Semiconductor team . . . They managed to get venture capital backing from the Dow–Corning group for this move.

Figure 3.1 represents a genealogy of Silicon Valley, showing the key initiating role of Fairchild Semiconductor, and the rapid growth of new small technology-based firms.

As mentioned earlier, the growth of the semiconductor industry in Silicon Valley was paralleled to the emergence of major companies elsewhere, notably Texas Instruments and Motorola. Bell Telephone Laboratories, a subsidiary of AT & T, also continued to make very significant contributions, although all of AT & T's output (via Western Electric) has been produced for its own use, in order to avoid anti-trust litigation. Bell has consistently spent large sums on basic research (it employs about 1,700 engineers and physicists on research at Murray Hill, New Jersey) and, along with other major companies, has accounted for a high percentage of major innovations in the semi-conductor field. This is illustrated in Table 3.6 for the two decades up to 1971. However, despite the dominance of large companies in basic invention and innovation in the semiconductor field, new technology-based small firms played a key role in their commercial exploitation, especially during the earlier stages of the US semiconductor industry's development.

From the late 1960s onwards, the output of the US semiconductor industry began increasingly to be concentrated in the top ten or so companies. Production economies of scale grew in importance (and plant size increased), as did production learning, and firms began actively to seek rapid movement along the 'production learning curve' (Scibberas, 1977). The importance of price in competition increased as the unit cost of semiconductor component production decreased (Chang, 1971). While the US semiconductor industry is now dominated in sales terms by a relatively few large companies, according to the President of Signetics Corporation, Charles C. Harwood (1978), commenting on the integrated circuit industry:

> A handful of highly diverse multinational companies will dominate the integrated circuit industry by 1985. They will have broad technology and product lines with worldwide production centres and sales. The giants will occupy the majority of the industry's market share, but certainly not all of it. Below them on the pyramid will appear both high-volume and low-volume specialists.

Thus, small specialist firms will continue to enter the market. It seems likely, however, that the major opportunities for new small firms will lie in the production of specialist devices based on the use of microelectronics components, and in the field of software production. Indeed, during the past few years in the US, there has been a proliferation of small software bureaux.

Our model of industrial evolution described in Table 3.5 implies a move from a focus largely on product innovation to one largely of process innovation. Figure 3.2 plots the cumulative number of patents issued in the US in the areas of 'semiconductor internal structure technology' and 'semiconductor preparation technology' between 1963 and 1974. It indicates that the balance of inventive activity is indeed moving from product (internal structure technology) to process (semiconductor preparation technology), which might be taken to support the validity of our model.

We see, then, an example of the evolution of a technology-based industry during the post-war era in which new small firms played a key initiating role on a broad front. As the industry grew, and price became a more significant factor in competition, economies of scale increased in importance and sales began to be dominated by the leading ten or so large firms, including a number that had grown rapidly from new technology-based firms founded during the 1950s and 1960s (e.g. Signetics; Intel; Fairchild Semiconductor). Technological innovation (nowadays primarily process innovations) continues to play an important role, and provides opportunities for smaller firms making specialist, low-volume devices.

Also of significance in the US context is the role played by existing larger companies, sometimes operating outside the electronics area, both in providing risk capital to fund the start-up of new semiconductor companies (e.g. Fairchild Camera Corporation, Dow-Corning) and by themselves diversifying into semiconductor production (e.g. Texas Instruments).

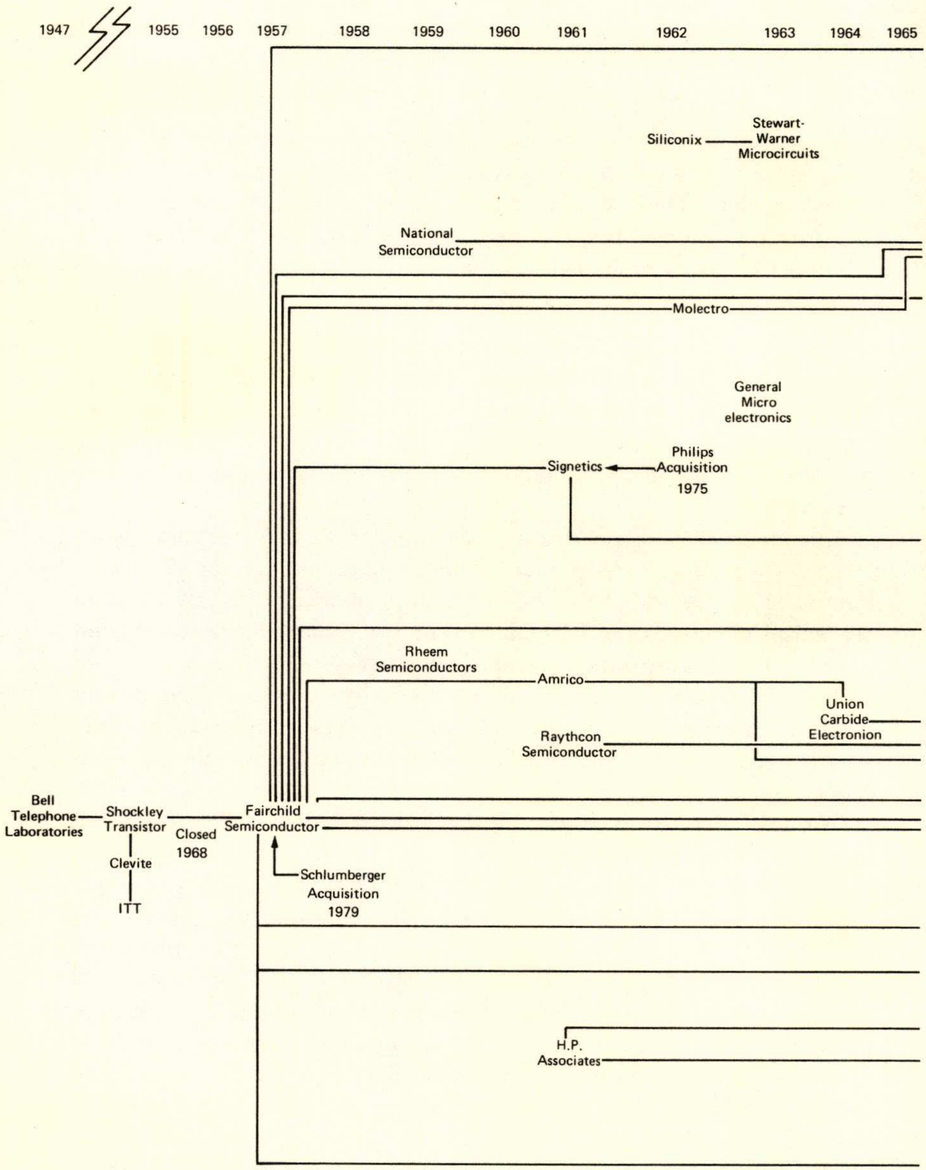
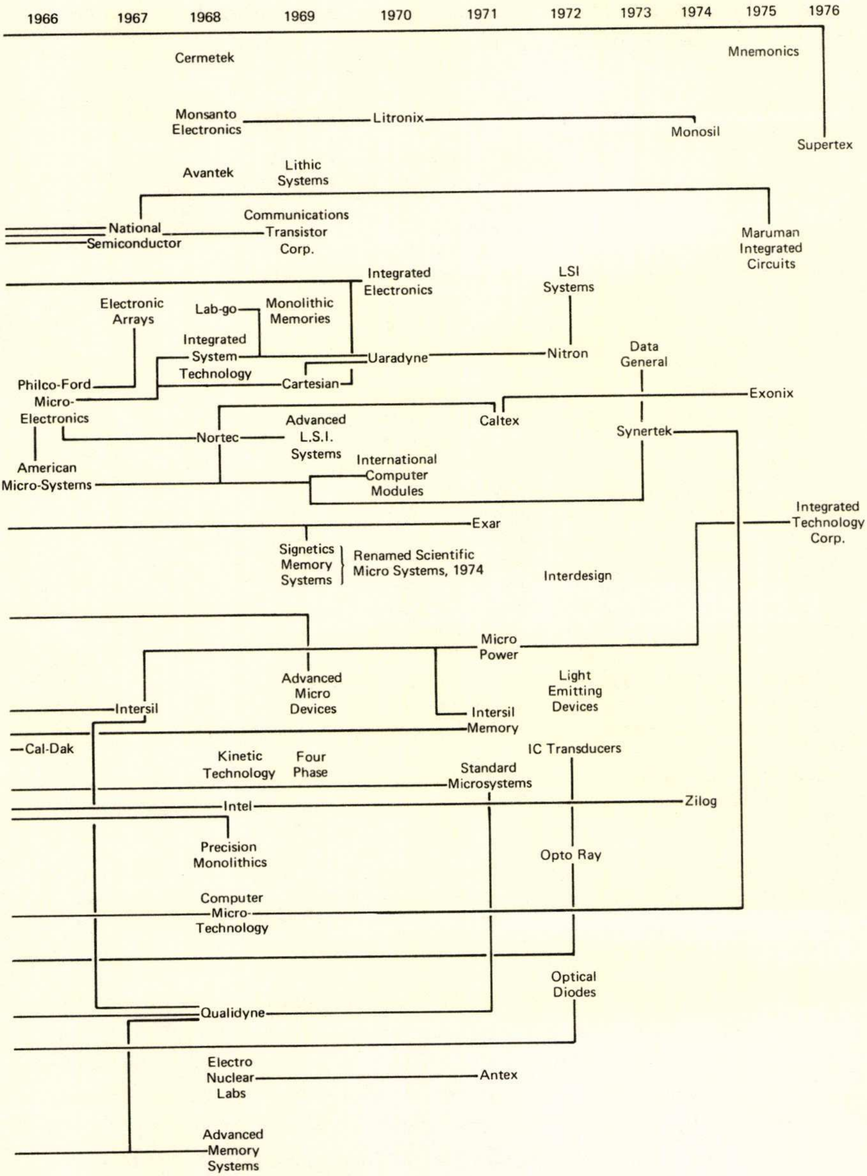


Fig. 3.1 Silicon Valley geneology. *Sources:* D. Mason, 1979.



1966
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Cermetek
Mnemonics
Monsanto Electronics
Litronix
Monosil
Supertex
Avantek
Lithic Systems
National Semiconductor
Communications Transistor Corp.
Maruman Integrated Circuits
Integrated Electronics
LSI Systems
Electronic Arrays
Lab-go
Monolithic Memories
Integrated System Technology
Uaradyne
Nitron
Data General
Philco-Ford Micro-Electronics
Cartesian
Exonix
Caltex
Advanced L.S.I. Systems
Nortec
Synertek
American Micro-Systems
International Computer Modules
Integrated Technology Corp.
Exar
Signetics Memory Systems
Renamed Scientific Micro Systems, 1974
Interdesign
Micro Power
Advanced Micro Devices
Light Emitting Devices
Intersil
Intersil Memory
Cal-Dak
IC Transducers
Kinetic Technology
Four Phase
Standard Microsystems
Intel
Zilog
Precision Monolithics
Opto Ray
Computer Micro-Technology
Optical Diodes
Qualidyne
Electro Nuclear Labs
Antex
Advanced Memory Systems

Table 3.6 Major product and process innovations in the US semiconductor industry

Innovation	Principal company responsible	Date
Point contact transistor	Bell Telephone Laboratories	1951
Grown junction transistor	Bell Telephone Laboratories	1951
Alloy junction transistor	General Electric Co., RCA Corp.	1952
Surface barrier transistor	Philco Corp.	1954
Silicon junction transistor	Texas Instruments, Inc.	1954
Diffused transistor	Bell Telephone Laboratories, Texas Instruments, Inc.	1956
Silicon controlled rectifier	General Electric Co.	1956
Tunnel diode	Sony (Japan)	1957
Planar transistor	Fairchild Camera and Instrument Corp.	1960
Epitaxial transistor	Bell Telephone Laboratories	1960
Integrated circuit	Texas Instruments, Inc., Fairchild Camera and Instrument Corp.	1961
MOS transistor	Fairchild Camera and Instrument Corp.	1962
DTL integrated circuit	Signetics Corp.	1962
ECL integrated circuit	Pacific (TRW)	1962
Gunn diode	International Business Machines Corp.	1963
Beam lead	Bell Telephone Laboratories	1964
TTL integrated circuit	Pacific (TRW)	1964
Light-emitting diode	Texas Instruments, Inc.	1964
MOSFET (MOS field effect)	Bell Telephone Laboratories; Philips (Holland)	1968
Collector diffusion isolation	Bell Telephone Laboratories	1969
Schottky TTL	Texas Instruments Co.	1969
Charge-coupled device	Bell Telephone Laboratories, Fairchild Camera	1969
Complementary MOS	RCA Corp.	1969
Silicon-on-sapphire	RCA Corp.	1970
Ion implementation	Bell Telephone Laboratories	1971

Source: D. W. Webbink, The Semiconductor Industry; Structure Conduct and Performance, unpublished Staff Report to the US Federal Trade Commission, January 1977.

It is also interesting to note that although the receiving valve companies in the US were among the first to manufacture transistors and were responsible for a high proportion of total industry R & D in the early years, their impact on the market has been small relative to that of the specialist semiconductor companies, most of which were new entrants to the electronics component industry. This might have been due partly to fear of anti-trust action following the publicity given to the AT & T case. It was perhaps due more to them grossly underestimating the potential of the new solid-state devices. As Mason (1979) puts it: '... Raytheon who concentrated heavily on transistors for hearing aids tended to adopt the

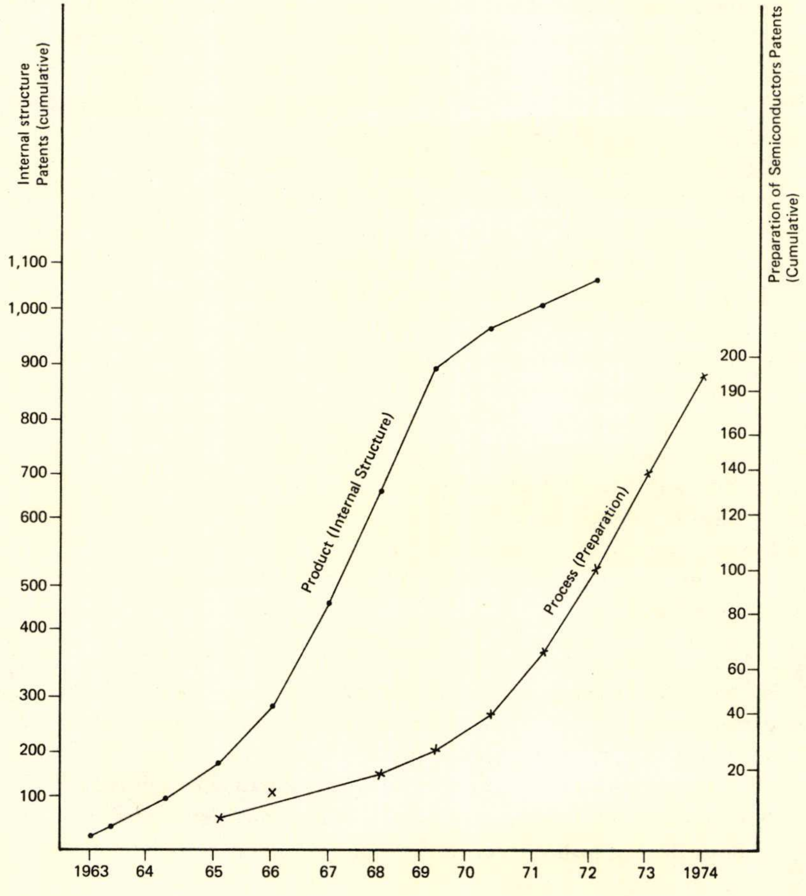

Fig. 3.2 No. of patents issued in the US in semiconductor structure technology, and semiconductor preparation technology. *Source*: D. Mason, 1979.

same viewpoint as RCA who saw that "the feeble amplification of the transistor could never compete with the well refined vacuum tube".'

In Europe, the development of the semiconductor industry occurred later than in the US. This does not appear to have been due to lack of technical know-how since at least three British R & D laboratories (STC, GEC, BTR) independently succeeded in reproducing the point contact transistor within weeks of the Bell Telephone announcement. As a result of this laggard behaviour, even as late as the mid 1970s, US firms had more than 50 per cent market share within Europe.

It is interesting that the mode of development of the European semiconductor industry was markedly different to that of the US industry. Within Europe (and in Japan) semiconductors were developed at a later date, diffused into general use less rapidly than in the US, and were produced mainly by established, relatively large firms, operating in the electronics area (e.g. Philips, Siemens, AEG). New small technology-based firms played only a minor role in the European semiconductor industry.

Thus, it appears that in the early stages of the semiconductor industry, when entry barriers were relatively low, and competition was based on product innovations, small entrepreneurial firms had a comparative advantage. Later, as scale economies became more important and price competition increased, the advantage shifted to larger firms capable of investing heavily in process equipment to produce more standard devices in high volume. It was during this later phase that large established European and Japanese companies entered the market. Subsequently, however, the now large US companies appear to have maintained both their technical and market leads, although they are currently under threat from Japan.

Finally, Zegveld and Prakke (1978) have offered a number of possible explanations for the different US and European semiconductor industry development modes:

> . . . on Route 128 and in Silicon Valley, Technology Oriented Complexes (TOCs) were created which consisted of a large number of entrepreneurial firms. These firms had strong relations with universities and government laboratories in the region, as well as with each other. Many of the firms were started by university graduates and as spin-offs from government laboratories. These institutions also provided a continuous flow of highly specialised engineers. Moreover, communications between firms was guaranteed by that peculiarly American habit of job-hopping. *Fortune** at one time estimated the job turnover in Silicon Valley at 15 per cent to 20 per cent per annum. Risk capital was amply and expertly provided by local venture capitalists, many of whom were graduates of the small firm experience. Apart from the highly visible effects such as industrial parks and stock market values, these firms had a profound effect on the structure of the American electronics industry . . . none of the leading vacuum tube manufacturers in the US survived to similarly lead in the production of semiconductors. In Japan, however, the established firms were able to make the switch to semiconductors without interference from small firms. In Europe, the traditional firms were also able to maintain their position.

* *Fortune* (1975), 2, 27.

It seems that two explanations are possible. They both throw a different light on the role of small firms as sources of technological change. The first explanation is that the success of the TOCs reflects a particularly American phenomenon. It is based on a culture that puts a low value on company loyalty and a high one on individual entrepreneurial activity. Innovation activity in large firms would be discouraged because of the threat technological change might present to individual job security. If this analysis is correct it would be unwise to expect much from recent European efforts to create TOCs . . . It would then be wiser for Europe and Japan to concentrate their efforts on improving the performance of established firms. The second explanation of the difference in the development of the US and non-US semiconductor industry lies in the fact that the US firms were at all times in the forefront of technological development in this area and that their European and Japanese counterparts can be said to have had the less risk-entailing task of following the leader. A strategy of being second-to-market involves less uncertainty than being at the forefront. The question can be posed whether large firms in Europe and Japan would have been equally successful if US industry, characterised by the large role of small firms, had not paved the way. There is a proposition in general systems theory which says that only complexity can destroy complexity. Translated to our area this could mean that in an area of rapid technological change, of which the outstanding environmental property is complexity, the most successful organisational response will also be characterised by complexity. Such organisational complexity seems to be better provided by a system of many small firms than by a few large ones. The conclusion would be that Europe and Japan will not be able to compete successfully with the US in advanced technology by concentrating technological development in their established firms. These firms may be quite advanced scientifically through close co-operation with European university laboratories. They may be quite successful commercially through use of a second-to-market strategy . . . but if the above explanation of the small firm phenomenon is correct they will go on being dependent on technical know-how developed in a system which tends to assign a specific place to small firms as creators of new technology.

New technology-based firms (NTBFs)

In the context of the evolution of the next generation of technology-based industries, e.g. bio-technology, energy technology etc., it might be that new technology-based firms will, as with semiconductors, have a key initiating role. There might once again, however, be marked differences in evolutionary mode between the US and Europe and Japan. Indeed, a fairly recent report on NTBFs in the US, the UK and West Germany, which was sponsored by the Anglo-German Foundation, presented data which suggest the large scale NTBF creation might be, in the main, a uniquely US phenomenon (Arthur D. Little Inc., 1977). Some of the main conclusions of this report are:

(1) While NTBFs have had a significant impact on the economy in the United States,* the number set up since 1950 and still in existence in the United Kingdom is only about 200, with total sales of about £200 million. In West Germany, the corresponding number of NTBFs is even less. The performance of NTBFs has been more impressive in the United States than in the United Kingdom and West Germany.

(2) Factors favouring the formation and growth of NTBFs in the United States are:

- a very large domestic market conducive to rapid growth and development;
- the availability of private wealth as a source of seed capital for the start-up of new ventures;
- a fiscal framework which encourages the flow of private risk capital into new ventures;
- the existence of an active market for trading of shares in new ventures, that is the over-the-counter (OTC) market;
- a prevailing attitude in society at large which encourages entrepreneurship;
- high mobility of individuals between academic institutions and private industry;
- the behavioural and attitudinal character of American scientists, many of whom are willing to establish their own business in order to exploit their technical knowledge;
- a large and active government expenditure programme which provides significant opportunities for NTBF endeavour, particularly through government procurement programmes.

(3) While the low level of investment and economic growth in the United Kingdom has had an adverse effect on the creation and growth of NTBFs, the much more favourable economic performance of West

* In 1977 there were several thousand NTBFs in the United States; sales turned into billions of dollars and they probably then employed in excess of two million. In the Silicon Valley area alone, for example, in 1974 there were 800 NTBFs with annual sales of $2.5 billion.

Germany has not led to the creation of large numbers of NTBFs. Therefore, while bad economic conditions can have a negative impact on the number and performance of NTBFs, a favourable economic climate, *by itself*, is not sufficient to generate NTBFs.

(4) Three negative factors common to both the United Kingdom and West Germany are:

– cultural and attitudinal factors among academics, government scientists and research institutions that have been unfavourable towards technological entrepreneurship;
– in the United Kingdom government R & D expenditure which has consistently neglected NTBFs – until recently the same was true in West Germany;
– the fragmentation of the European market which has restricted the growth of NTBFs in both countries.

(5) The systems of taxation in the UK and West Germany have been such as to disfavour NTBF formation. In both countries, however, since the A. D. Little report was completed, there have been attempts to relieve the corporation tax burden on small companies, and in the UK the maximum personal level of taxation has been reduced from 80 to 60 per cent. The latter should facilitate the accumulation of private savings and make the investment of savings in high risk, high return ventures more attractive.

(6) Venture capital for NTBFs is more easily available in the United Kingdom than in West Germany, and there are more than a dozen UK institutions which provide venture and development capital for SMEs. However, NRDC and TDC are the only UK institutions which really focus on NTBFs. In general, traditional sources of finance in the United Kingdom are receptive towards new and developing ventures with high growth potential. More recently, in West Germany, steps have been taken to increase the availability of risk capital.

There is also evidence from the US to suggest that government procurement played an important role in stimulating the growth of infant industries by reducing market entry risks. Of particular interest here is the development of the US semiconductor industry: while most of the important initial inventions and innovations were made by private firms on their own initiative, US military procurement undoubtedly created a climate conducive to private investment in this area. According to Golding (1978), 'The Armed Services, by stressing their willingness to buy small quantities of high technology items, were successful in creating a climate of opinion conductive to invention.'

This appears to have been rather more important than direct government R & D support (Utterback and Murray, 1977). Further, US government procurement appears to have had its major impact in accelerating the diffusion process, i.e. in facilitating the widespread commercial adoption of semiconductor components.

Analysis of the dates of formation of some of the NTBFs in the A. D. Little sample are interesting. Taking forty-one NTBFs in the US, ninety-three in the UK and forty-eight in West Germany, founded between 1948 and 1975, then the median formation dates (i.e. the dates at which 50 per cent of the firms in each sample were founded) are 1957, 1964 and 1966 respectively. This suggests for NTBFs generally (as with the specific case of semiconductors) that technological opportunities were grasped in the US earlier than they were taken up in Western Europe.

While, as stated above, venture capital has historically been more readily available in the US than in Europe – there are now about eighty private venture capital companies in the US – there is evidence to suggest that during the 1970s the financing of new ventures declined. This trend is illustrated in Table 3.7.

Table 3.7 New venture financing in the US, 1970–80

Year	No. of initial public offerings on the new-issues market	Approximate funds invested ($ millions)
1970	358	825
1971	391	1,650
1972	568	2,750
1973	100	400
1974	15	–
1975	15	300
1976	34	–
1977	40	–
1978	46	250
1979	81	500
1980	250*	1,000*

* Estimated. In 1980 approximately 60 per cent of total investment went to high technology ventures.

Source: Business Week, 10 November 1980.

The figures in Table 3.7 are for the financing of new ventures generally. The data in Table 3.8 are for the financing specifically of NTBFs.

Table 3.8 NTBF financing in the US, 1969-78

Year	No. of NTBFs financed by public issues on the US stock market	Funds invested ($ million)
1969	204	349
1971	73	138
1974	4	6
1978	37	–

Source: Capital Formation, US Senate Select Committee on Small Business, 1978.

Morse (1976) also identified a distinct decline in venture capital investments in new projects in the US for several years after 1974 as well as a general decline in the number of small technical companies financed by public issues. This decline in venture financing activity he attributed largely to an increase in capital gains tax in the US from 25 to nearly 40 per cent in 1976, and to regulations concerning the use of pension funds. In 1979 the tax rate was lowered to 30 per cent and pension fund managers were once again allowed to invest in innovative small firms.

The 'oil crisis' of 1974 also undoubtedly played an important part in the decline in venture capital availability in the US during the mid 1970s, as did rapidly increasing rates of inflation, since both badly shook the confidence of managers and investors alike. It might be, however, that a perceived decline in the number of suitable technological opportunities for would-be technical entrepreneurs occurred also; that in most existing areas of technology the dominance of large corporations made it increasingly difficult for new small firms to compete. In other words, the existence of strong oligopolies operating with mature, or maturing, technologies significantly raised the barriers to new small entrants. It is interesting to note that in 1980 in the US a large percentage of venture-capital funds devoted to high technology ventures went to firms operating in the areas of microelectronics and bio-technology, the first representing 'phase 2' of the semiconductor revolution, the second the seed corn of a whole new area of technico-economic activity.

In respect of differences between the US and Europe, it is interesting that discussions with a major UK firm with interests in bio-technology have elicited the attitude that the emergence of new bio-technology-based firms in the US might be a 'flash in the pan'; that bio-technology will be so capital-intensive that new technology-based small firms will be unable to compete. Such scepticism was similarly voiced by leading UK electronics firms in the early 1950s concerning the emergence of the US semiconductor industry. It ignores the fact that new technology-based firms in the US are often taken over by large corporations with ample funds for capital investment; that large US corporations are often willing providers of venture capital for promising newcomers; and that small, innovative companies can license their innovations for production by large corporations, as is currently happening with the production of a new form of 'human' insulin. It would be a pity if such attitudes meant that major European firms were once again to enter the race at a late stage, thus sacrificing potential technical and market leads to the US.

This is unlikely to be the case with the large Japanese corporations, which appear to be adopting a vigorous stance towards new technological opportunities and, certainly, Japan currently appears to be the leading country in patenting activity in the area of bio-technology. In the Japanese case, company attitudes are very much linked to a forward-looking, technology-based government strategy, and emerging areas of technology are attracting strong government financial support.

Thus, it is interesting to speculate that the 'new' waves of technology will be exploited in the US initially through the emergence of NTBFs backed by, and in parellel with, the efforts of existing large corporations. In Europe, existing firms might once again play the major role, perhaps lagging behind their American counterparts in commercial exploitation. In Japan existing large corporations, backed by strong governmental cash and infrastructural technical support, will lead the way. It will be interesting to see which system of development wins the race for technical and market dominance.

Finally, while we have concentrated in this chapter on discussing the role of new technology-based manufacturing firms, it is worthwhile noting the apparent shift that has taken place in the incidence of entrepreneurship towards the service sector. In most of the advanced market economies there has been a marked growth in entrepreneurial activity in the areas of software, public relations, and marketing, management and technical consultancy work. Many small firms have been created in these areas. Thus, there currently appears to be no marked lack of entrepreneurship *per se*, but rather in some countries a lack of technological entrepreneurship. It appears that while the barriers to start-up in manufacturing are high (as can be the penalty for failure), in services these barriers are very much lower. This suggests that the most significant contribution governments can make in this area is to lower the barriers to entry. The greater provision of venture capital is of obvious importance in this respect, as is the lowering of market entry risks through public procurement. The role of government policy is discussed in some detail in chapter 9.

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4 THE ROLE OF SMEs IN INVENTION AND INNOVATION

1. Introduction

A great deal has been written concerning the innovativeness of SMEs in comparison to that of larger companies. It has on the one hand been argued that large size and monopoly power are prerequisites for economic progress via technical change, while on the other hand it has been argued that small firms are more efficient at performing innovative activities and are, in fact, the major source of innovations.

Perhaps the most notable protagonist of the argument for large size and monopoly power is J. K. Galbraith, whose position is succinctly stated in the following quote from his *American capitalism* (1957):

> A benign providence . . . has made the modern industry of a few large firms an almost perfect instrument for inducing technical change . . . There is no more pleasant fiction than that technical change is the product of the matchless ingenuity of the small man forced by competition to employ his wits to better his neighbour. Unhappily it is a fiction. Technical development has long since become the preserve of the scientist and the engineer. Most of the cheap and simple inventions have, to put it bluntly, been made.

The fact that invention has come to rely more on the expertise of qualified scientists and engineers does not, of course, make it the exclusive preserve of 'large firms' and necessarily prevent small firms from innovating. This appears to have been true especially in the US where in some areas, for example electronics, small new technology-based firms have played an important role as innovators. Thus, during the post-war years in the US – and to a lesser degree, elsewhere – we have seen the emergence of a new breed of technological entrepreneurs. Further, if large firms have increasingly become the source of major inventions – this question will be discussed below – this does not necessarily debar small firms from becoming innovators. Moreover, it might be that in some areas invention relies rather more heavily on qualified scientists and engineers than does innovation. Thus while Table 3.6 showed that most of the major product and process inventions (and innovations) were made by large companies in the US semiconductor industry, small firms nevertheless played an important part in innovation and commercial exploitation, as was indicated in Figure 3.1.

Perhaps Schumpeter (1939) was closer to the truth. He emphasized that while entrepreneurs play a significant part in the establishment of new branches of industry, during the later phases of industrial development innovation increasingly requires large firms because of the high costs involved, and considerable market power if innovation is to be worthwhile. This accords well with our model of industrial evolution outlined in Table 3.5. Moreover, the role small firms can play in innovation will depend on a number of factors specific to the technology itself and to the structure and requirements of the market place. Small firms are therefore unlikely to play an important part in innovation where capital costs are high and where large scale economies are necessary, but may play a significant role in highly segmented markets for specialist products.

The role of small firms in R & D expenditure, invention and innovation will be discussed below. In order to place this discussion in context, it is necessary first to outline some of the major problems and advantages of small firms in innovation.

2. Advantages and disadvantages of SMEs in innovation

The arguments concerning the relative advantages and disadvantages of small firms in innovation do, as seen earlier, revolve largely round the question of the advantages and disadvantages of scale. To offer a detailed analysis of this issue, therefore, would require discussion at the level of the individual industry, each with its own particular set of technological and market requirements. Moreover, the Schumpeterian analysis of economic development imposes the requirement for consideration of the age of the industry and its stage of development.

Thus, the relative advantages in innovation of a new technology-based small firm operating with a newly emerging technology in a fluid, rather undefined market are different to those enjoyed by a long-established small firm operating in a traditional area, e.g. textiles or footware. Similarly, the advantages and problems facing a small firm in an established, but nevertheless technology-based, field (e.g. scientific instruments) might differ to some extent from those above. Despite these differences, a number of generalizations can be made. The discussion below is taken largely from a previous publication by the authors (Rothwell and Zegveld, 1978).

Advantages

Marketing

This is an area where, in some instances, SMEs have a comparative advantage over their larger counterparts. They develop specific capabilities in certain technological areas, serving a narrow but sophisticated market; through close contact with customers they keep abreast of often fast-changing market demands, and are able to react *quickly* and *efficiently* to both market and technological changes. They do not suffer from the bureaucratic inertia that often afflicts very large enterprises and thus enjoy the advantages of rapid, flexible response to demand shifts. In some areas, e.g. the European agricultural implements industry, innovative small firms can dominate narrow market segments (Rothwell, 1979).

Dynamic, entrepreneurial management

Small high-technology firms are often controlled by dynamic entrepreneurial characters who react swiftly to take advantage of new opportunities. Large firms, in contrast, often possess a management structure that stifles entrepreneurial endeavour. Indeed this has been recognized for some time in the United States, where a number of very large corporations have reorganized their new product development efforts along small-firm lines (Rothwell, 1975). (See also chapter 6.)

A second point is that entrepreneurs who have founded their company on a particular innovation are perhaps more amenable to undertaking subsequent high-risk innovation projects than managers in large companies, which are often controlled by accountants who are adverse to risk-taking. Further, the formal project selection and evalution techniques often employed by decision makers in large companies might contain an inherent bias against high-risk innovations.

Internal communication

The efficient running of any organization requires good internal communication. Small firms often enjoy an advantage over large firms because of the ease with which they can organize internal communication. There is less need to establish sophisticated formal communication networks in small firms, where communication is most often of an informal reactive kind, and where it generally occurs very rapidly offering a fast response to internal problem-solving and in reorganizing to adapt to changes in the external environment. Good internal communication also contributes to good labour relations in SMEs, which can, in turn, facilitate their adoption of innovative new production machinery.

Disadvantages

Manpower

Innovation, and particularly radical innovation, normally requires the use of qualified engineers and scientists. SMEs, which do not normally possess a formal R & D department, and which can afford to spend only small sums on technical developments, often experience considerable difficulty in attracting and financing on a permanent basis one or more qualified engineers and scientists. As the data in Table 4.1 indicate, both the absolute number and relative percentage of professionals in R & D employed by enterprises in West Germany with less than 500 employees declined considerably between 1964 and 1973 (Echterhoff-Severit, 1977).

Table 4.1 Professionals in R & D in West German enterprises by size of firm in 1964 and 1973

Size of firm (employees)	Year	Professions in R & D	
		Number	Percentage of total
Less than 500	1964	576	5.2
	1973	390	2.1
500 to 1,999	1964	1,002	9.1
	1973	1,728	9.3
2,000 and	1964	9,472	85.7
more	1973	16,397	88.6

A recent study of innovation and competitiveness in fifty-six smaller companies in a variety of industries in the UK has highlighted the problems SMEs can suffer due to shortages of skilled manpower (CBI, 1979). The study found that the shortage of technically qualified employees was acute at all levels and was clearly impeding innovation and growth in every respect.

A second UK study, this time of forty firms in the plastics processing industry, also found that shortages of technically qualified manpower, especially in the smaller firms, imposed limits on innovation and growth (Walsh *et al.*, 1980). However, while the total number of qualified staff employed by the firms in this sample was strongly related to firm size, the proportion of qualified staff to total employees was almost independent of firm size.

A third study in the UK, of the agricultural implements industry, again highlighted the negative impacts of lack of technically qualified manpower on innovation in smaller firms (Rothwell, 1979). The study also highlighted the paucity in small firms of suitably qualified production engineers; most of the twenty-six small firms covered by the study did not employ a single production engineer, which considerably affected their ability to design for 'makeability' (Rothwell, 1980a).

Finally, the marketing of complex, high-technology goods often requires teams which include technically qualified members, as does the aftersales servicing of sophisticated equipment. This is a costly business, which can, once again, put SMEs at a disadvantage relative to large firms. In areas in which dealer networks play an important role, small firms can be disadvantaged because of difficulties in obtaining comprehensive dealer representation for their innovative new products. This often relates to dealers' concern about the firm's ability to supply the necessary high level of aftersales technical servicing to complement their own efforts.

External communication

To enable a firm to undertake the rational planning and assessment of innovatory endeavours, a great deal of information is needed on a variety of subjects, such as the market situation, new technological developments, sources of technical assistance, government promotional measures, etc. Because of their lack of resources, SMEs are at a disadvantage in gathering and analysing such information. A recent survey in West Germany has shown, for example, that relatively few small enterprises attempted to forecast technological developments, a major reason being that they regarded gathering pertinent information as being too expensive; further, funds for hiring qualified employees to perform this work were not available (Oppenländer, 1976). A second survey in West Germany showed, with respect to information on economic developments, that most smaller firms were similarly unable to gather and analyse data useful for their specific needs. Smaller firms also bemoaned the absence of publicly available data on probable developments of small sectors of industry or on specific markets, which would be more useful to them than standard macro-economic projections (Newman, 1973).

A crucial area in which small firms are disadvantaged *vis-à-vis* larger firms is in the gathering of scientific and technical information. In this respect small firms often suffer from a serious information gap, which is made worse through the inability of SMEs to establish comprehensive library and data retrieval systems and to send personnel to conferences and seminars. As a result of this, small firms can become introspective, seeking

Table 4.2 Sources of innovative ideas by size of firm (in-house or external) for the periods 1945–69 and 1970–80. (2,100 important innovations introduced by British industry industry between 1945–80: (Townsend, Henwood and Thomas, SPRU Innovation Data Bank, 1981.)

	Size of firm (no. of employees)				
	1–199	200–499	500–999	1,000–9,999	10,000+
1945–69					
No. of innovations	172	97	71	389	702
In-house (%)	82.6	83.5	90.1	69.7	57.7
External (%)	17.4	16.5	9.9	30.3	42.3
1970–80					
No. of innovations	94	58	26	106	380
In-house (%)	68.1	87.9	92.9	79.1	76.8
External (%)	31.9	12.1	7.1	20.9	23.2

ideas mainly from within and lacking awareness of new technical trends and opportunities.

The data presented in Table 4.2, taken from the Science Policy Research Unit's data bank on major post-war British innovations, are interesting. They show that during the period 1945–69, smaller firms did indeed obtain a significantly greater percentage of innovative ideas in-house than the larger firms in the sample. Between 1970 and 1980, however, the pattern for firms in the smallest size category (less than 200 employees) and those in the largest two categories (more than 1,000 employees) changed. The small firms obtained an increased percentage of innovative ideas from external sources, while the large firms demonstrated the reverse tendency. For firms in the intermediate size categories (200–999 employees), the percentages remained relatively unchanged.

Taking first the large firms (1,000+ employees), their increased apparent introspection might be the result of a combination of factors: the firms are now operating with technologies with which they are familiar, and have built up in-house R & D capabilities in these areas; the technologies are relatively mature, thus attracting less attention in government

R & D establishments, university research departments and research associations (these sources accounted for 22.6 per cent of all large firm innovation ideas between 1945 and 1969 and 16.8 per cent between 1970 and 1980); because of the crisis of 'stagflation' during the 1970s, the large firms are operating more within existing technological boundaries and are less actively seeking radical ideas from external sources. Thus, the large firms have become increasingly self-contained with respect to innovation.

Explaining the increasing use of small firms of external sources of innovative ideas is rather more difficult. In terms of sources of external ideas, the percentage deriving from the scientific and technological infrastructure declined from 12.9 per cent during 1945–69 to 10.8 per cent during 1970–80. The only dramatic change is in the percentage of ideas derived from 'related industry', which increased from 7 per cent during 1945–69 to 24.6 per cent between 1970 and 1980. (During the same periods, the share of small firms in innovation increased from 12 per cent to nearly 17 per cent – this issue is discussed in some depth later in this chapter.) Thus, for whatever reason, small firms have, during the past decade, obtained significantly more ideas for innovations from other firms operating in related areas. It might be that many of these ideas derived from large firms who, being interested in economies of scale and large markets, were happy to allow their exploitation by small firms which are happy in turn to produce specialist goods on a small scale for specific market niches.

Finally, many small firms find it extremely difficult, because of lack of resources, to keep abreast of the plethora of government measures available to assist them in their innovatory endeavours. For example, Rubenstein *et al.* (1977), from a study of the influence of government policy on innovation in five countries in Europe and in Japan, found that small firms, especially in the UK and France, were largely unaware of the range of policy measures open to them. Clearly, the implication for governments of this conclusion is that they should adopt a very much more positive stance towards the dissemination of information describing available innovation assistance for small firms.

Management techniques and practice

While small entrepreneurial firms often enjoy the advantages of dynamic open-minded management, SMEs in traditional areas of manufacturing sometimes suffer through possessing a 'Dickensian' management structure. In the latter instance, the firm is headed by an all-powerful autocrat, who refuses to listen to advice from his subordinates and who runs the firm entirely as he sees fit to do so. If this autocrat is suitably gifted, the firm thrives; if not, the firm declines, and there is little or nothing anyone can do about it. Even in the former case the firm will eventually run into trouble since it will have to face the problems of succession when the autocrat retires. In such companies, normal theories of management practice have little meaning, and it is difficult to see what can be done by government or anyone else to improve the situation.

Even in SMEs possessing democratic, consultative managers, problems can exist because of their lack of management expertise. This often manifests itself in an inability to plan properly for the future. In a time of accelerated technical, social and economic change, the formulation of a corporate strategy, and of plans to implement such a strategy, is essential. This is a particularly weak point in SMEs. As an indication of this, a survey in West Germany in 1974 showed that even in those firms having a formal R & D budget, only 11 per cent of these employing fewer than 200 derived it from a corporate plan extending over seven years; the comparable figure for firms employing 5,000 or more was 53 per cent (Stroetmann, 1979).

Finally, in the study of the UK plastics processing industry mentioned earlier, Walsh *et al.* (1980) found that skill shortages affected adversely innovation and growth particularly severely in those firms that lacked explicit strategies. Significantly, this was most often the case with small firms.

Finance

Innovation is both costly and risky and small firms often experience constraints due to their lack of financial resources (Wilson, 1979). Certainly few small firms can afford to spread the risk by embarking on several projects simultaneously. Large firms, in contrast, are able to diversify the risk through having a portfolio of projects at different stages of completion. SMEs also appear to experience greater difficulty than do large firms in raising capital for high-risk projects and particularly in raising longer-term capital (Waite, 1973).

Finally, marketing start-up with new innovative products can be both difficult and costly. With certain types of equipment, such as farm machinery, the cost of market start-up abroad can be prohibitive for many small firms since it involves actual demonstrations of the machine's performance on site, which is an expensive and time-consuming business beyond their financial capabilities. One small UK agricultural engineering firm, for example, reported spending £40,000 on the development of a new machine, and £50,000 on demonstrating this machine in a single country in North Africa.

Economies of scale and the systems approach

In some areas economies of scale form a substantial entry barrier to small firms (such as automobiles, consumer durables). SMEs can, however, play a substantial role as suppliers of components and sub-assemblies to large manufacturers. If SMEs wish to enter these areas, they can only do so by offering highly innovative, individualistic products at the top end of the market (for example Sinclair calculators, or Aston Martin automobilies).

A second size barrier is the growing need in some areas to offer integrated systems, and this is particularly true where turnkey projects are required. SMEs are unable to offer a fully integrated range of products which can put them at a great disadvantage *vis-à-vis* large firms, partly because intermediaries find it easier (and often more profitable) to deal with a single large company rather than with a number of small suppliers, and partly because of problems of equipment compatibility.

Ability to cope with government regulations

One area in which SMEs appear to be particularly disadvantaged is the relatively inordinately large impact they can suffer through governmental regulations (for a more detailed discussion of this issue, see Rothwell 1980b, 1981). There are a number of aspects to this: first of all, the mere existence of regulations is especially burdensome to SMEs; second, the cost of compliance can be prohibitively high to them; third, SMEs might possess neither the technical nor the legal expertise necessary to cope with technically or legally complex compliance problems.

Weidenbaum (1978) has addressed the question of the impact of regulations on SMEs in the United States, where the rate of promulgation and severity of regulations has been particularly high. He states, for example, that the unit cost of meeting the form-filling requirements of a National Labour Relations Board election is smaller for the large firm ($101.60 for companies with over 1,000 employees) and larger for the small firm ($134.60 for firms with fewer than one hundred workers).

The American Chemical Society, commenting on the impact of the Toxic Substances Control Act (TSCA) on the US industry in 1979, mentions the results of a report to the EPA which estimates that a small chemical company with annual sales of $100,000 would have its after-tax profit reduced by 13.3 per cent simply from the cost of preparing the mandated inventory of products and intermediates; the cost for a company with annual sales of $100 million would reduce after-tax profits by only 0.4 per cent.

In the United Kingdom SMEs suffer mainly through social legislation –

and in particular, the Protection of Employment Act – and from the sheer volume of legislation and official returns. A recent report for the Confederation of British Industry (1979) found that while managers in companies of all sizes found the time taken to comprehend and become familiar with the plethora of Acts and Orders promulgated in the previous five years increasingly burdensome, this was particularly so for SMEs. The latter found that much valuable management time that should have been spent on expanding and improving their businesses was being expended on coping with this burden.

Another important problem is that of market size. In areas such as pharmaceuticals and pesticides, small specialist firms, and large firms operating in small specialized markets, are likely to be disadvantaged through government regulation. In the first case, few small firms can afford the cost of testing new drugs or pesticides (even if they succeed in meeting development costs); in the second case, the high cost of testing is likely to make small markets uneconomic.

Thus, in some areas, the high costs of regulatory compliance act to the particularly disadvantage of existing small firms; they can also impose a considerable barrier to potential new entrants. Further, if because of rate-of-return regulation an Averch-Johnson type of effect occurs, then rapidly increasing capital intensity will pose yet another barrier to the entry of new small firms.

Growth problems

During the post-war era many initially small, new technology-based firms have grown rapidly to international importance. Other firms, often in traditional areas of industry, have remained small for many years, and appear to have little ambition to grow. The reasons for the non-growth of small firms are many and varied, ranging from economic factors to sociological ones.

With respect to the latter, a number of managers of small, long-established agricultural engineering companies in the UK stated explicitly that they had no desire to expand. Each company represented a well-balanced social group in which labour relations were excellent and everybody was individually known (Rothwell, 1979). Growth, it was felt, would disturb the balance and introduce problems of labour relations and control. Indeed, because of problems of control and labour relations, a number of progressive, fast-growing firms in the UK deliberately, despite possible disadvantages such as loss of scale economies, limited unit size at any one location to about 500. The preferred arrangement was a number of separate units located in a limited geographical area (CBI, 1981). A third

UK study of small firms found that many businessmen running family-controlled firms saw, because of high rates of income tax and high capital transfer tax, little incentive to expand beyond the minimum level necessary for continued viability (CBI, 1979). On the other hand, Senker (1979) found that the personal goals of owners, along with a marked aversion to risk-taking, were more important than financial factors in preventing small firms in the UK press tool sector from expanding and investing in new technology.

A second problem is that of adapting to the changes in management style necessary to make the transition from an 'entrepreneurial' to a 'planned' company. Senker (1981), commenting on three industries in the UK (forklift trucks, minicomputers and plastics injection moulding), suggests that many transitional problems may be symptomatic of an apparent general lack of respect of British entrepreneurs for professional expertise. Certainly the transition often requires new and different skills and Walsh *et al.* (1980) found that firms making this transition began by appointing people to middle management positions (previously non-existent). Moreover, the quality of staff appointed was crucial, and Walsh *et al.* found that those firms with more highly qualified staff were generally most successful.

Access to finance can also be a major problem for small firms wishing to expand. Binks (1980), for example, found that the smaller the firm, the larger the proportionate increase in capital base required to respond to an increased demand, but the lower its ability to command loan and equity finance. Moreover, the more innovative the firm's products are, the greater the difficulty they experience in obtaining cash to fund their developments on which growth is to be based.

Finally it has often been said that many innovative SMEs, particularly in the UK, suffer from a 'post-development gap', i.e. they appear to be unable, or unwilling, to make the transition from small scale to large scale production. This might be associated with problems of obtaining finance to fund the high cost of large scale manufacturing start-up and of establishing comprehensive distribution and servicing facilities. It might equally be the result of an apparent preoccupation on the part of technological entrepreneurs in the UK with the 'inventive' aspects of their work, to the detriment of the purely commercial aspects. Once a particular innovation has reached the market, their attention is directed largely towards the technical aspects of the follow-up innovation, leaving the first under-exploited. This underlines the need, as discussed in chapter 6, for a more even 'balance of functions' within the firm.

To conclude, while SMEs enjoy a number of advantages over large firms in the innovation process, such as flexibility, dynamic response to market shifts, entrepreneurial environment, they also suffer from a number of inherent disadvantages. These disadvantages are mainly related to scale, that is, lack of cash and qualified manpower resources and an inability to obtain economies of scale in production and distribution. This lack of resources means that SMEs are less able to accommodate the high risks involved in innovating than their larger counterparts.

Government policies towards SMEs should therefore be aimed at helping them overcome the disadvantages of small scale and at reducing the technical, financial and market risks to them in developing highly innovative, specialist products, in which area their comparative advantage over large firms generally lies. Assistance should also be made available to SMEs to help them cope with problems of regulatory compliance.

3. The role of SMEs in R & D, invention and innovation

In this section we shall attempt to assess the relative contributions small firms make to national R & D expenditure, to invention and to innovation. It must be noted at the outset that information on these points is often incomplete, and national systems of measurement do not always precisely coincide. Nevertheless, a number of useful observations can be made and some valid conclusions can be reached.

In looking at inputs to the innovation process (e.g. R & D expenditure, R & D personnel) and the outputs from that process (e.g. patents, number of innovations, value of new product sales), there is an at least implicit assumption that some form of direct relationship exists between them. A number of analysts have, indeed, sought and found convincing correlations between innovational effort and innovational output (Müller, 1966; Comanor and Scherer, 1969; Scherer, 1970). Kamien and Schwartz (1975), however, add a note of caution concerning the apparently convincing correlations between various measures of innovative input and output. They point out that while 'there seems little doubt that on average a direct relationship between innovational effort and innovational output exists . . . it is likewise true that the transformation may depend on factors other than effort, and it may not be linear.'

It seems sensible to suggest that the input/output relationship will be different for different sectors of industry operating with largely differing technologies, and that in each sector the relationship will vary from firm to firm, some firms achieving a high internal transformation efficiency, others less efficient. It might also be that the transformation efficiency varies with firm size, thus giving different values for highly concentrated and for highly fragmented industries. This question will be discussed below.

(i) *R & D expenditure and firm size*

According to Kamien and Schwartz (1975), on the basis of a detailed literature survey, empirical evidence indicates that for those firms that undertake R & D, innovational effort tends to increase more than proportionally with firm size up to a point that varies with industry sectors. Beyond some magnitude, size does not appear to be especially conducive to innovatory effort or output. It is important to note, however, that many SMEs do not engage in formal R & D (probably less than 5 per cent of firms employing under 200 perform *formal* R & D), while most large firms do so.

Taking company-financed R & D only (as opposed to total R & D performed, which might include government-funded work), differences in R & D expenditure by size of firm generally become less marked (this, again, refers to firms that *do* perform R & D). This reflects the generally heavy concentration in most countries of government-funded industrial R & D in a handful of the largest firms. From a detailed analysis of patterns of industrial R & D expenditure in the US Soete (1978) has provided data to show that:

- Absolute R & D is not only concentrated among the large firms but this pattern seems to be more and more prevalent.
- Privately financed R & D is also highly concentrated among the biggest size classes.
- With regard to R & D concentration, expressed as R & D funds as a percentage of sales, Soete's data show that while in 1967 the relatively 'small' firms were the leading R & D firms, explaining the very high R & D/sales ratios, from 1969 on, they were replaced in the R & D lead by larger size firms bringing size of R & D and size of sales more in line. (In Soete's analysis, however, the smaller firms are those with a turnover less than about $500m per annum. Clearly his data have little bearing on the discussion of SMEs as defined in this book, but are nevertheless interesting).

There are also large differences in the variation by firm size of the R & D concentration ratio between industry sectors and Freeman (1974) has shown that in some sectors there is an inverse correlation between research intensity and firm size. A recent study of innovative firms in five industries* in Canada has also indicated that the R & D intensity of small

* Telecommunications equipment and components, electrical industrial equipment, plastics compounds and synthetic resins, smelting and refining and crude petroleum production.

firms can be as high as, and even higher than, that of large firms (De Melto *et al.*, 1980). The data are presented in Table 4.3 and show that the smaller firms are at least as R & D intensive as the bigger firms in terms of the R & D/sales ratio, and more intensive on the ratio R & D expenditure per employee. The data on R & D expenditure per R & D scientist and engineer show that R & D workers in the smaller firms are at least as well endowed as those in the largest size category. Needless to say, the absolute level of R & D effort (both in terms of qualified manpower and expenditure) was greatest in the largest size firms. (The above data refer exclusively to Canadian-controlled companies.)

Of further interest in this study was the fact that there was a clear tendency for foreign-controlled Canadian-based firms to spend less than Canadian-controlled firms on R & D per dollar of sales. This was attributed to the greater tendency of foreign firms to import technology, primarily from a parent or affiliated firm abroad, and for innovations resulting from imported technology to require significantly less R & D spending. Thus, when addressing the issues of R & D expenditure, patenting activity and the production of innovations, it is clearly necessary, when looking at firm size effects, to make the distinction between 'size of firm' and 'size of innovating unit', since the data can be seriously affected by patterns of ownership.

Turning back to the question of R & D expenditure by size of firm, Table 4.4 presents aggregate data for three countries. Some interesting differences emerge between the mature economies of West Germany and France and that of Israel. In the former, despite the fact that SMEs account for a significant proportion of total manufacturing employment, they account for only a very small proportion of national industrial R & D expenditure. In Israel, whose economy is dominated by many small firms, a high percentage of which produce technologically-based products, small firms enjoy a much higher proportion of national industrial R & D. In the UK, the situation is rather similar to France and West Germany, in that small firms probably account for less than 5 per cent of national R & D, but a significantly higher percentage (about 18 per cent) of total industrial output. Similarly in the US (where the top 400 or so firms account for more than 90 per cent of total US company-financed R & D) and in Japan, R & D expenditure is highly concentrated in the larger firms. Moreover, in all countries, there are large variations between industry sectors.

The evidence concerning the concentration of R & D resources in large companies should not be interpreted as suggesting that giantism should be encouraged on the basis that this would result in an increase in R & D

Table 4.3 Indications of R & D intensity by firm size in Canadian industry (the data refer solely to Canadian-controlled firms).

No. of employees in the field	No. of firms in sample	R & D/ sales ratio (mean %)	Firm size	No. of firms in sample	R & D expend. employee in the field (mean $)	No. of firms in sample	R & D expend./ R & D scientist and engineer (mean $)
50 or less	34	11.2	0–50	33	6,889	30	34,615
100 or less	45	10.1	51–100	11	2,901	10	48,793
200 or less	54	9.1	101–200	8	2,111	7	39,914
500 or less	60	8.4	201–500	9	1,030	6	32,368
More than 500	5	10.3	500+	5	2,163	3	38,333

Source: Reproduced with permission from Economic Council of Canada Discussion Paper No. 176, 'Preliminary Report: Innovation and Technical Change in Five Canadian Industries' (Ottowa, 1980), by Dennis P. De Melto, Kathryn E. McMullen and Russel M. Willis, Tables 13, 17 and 18, pp. 44, 48 and 49.

Table 4.4 R & D expenditure, output and employment of SMEs

France, 1972: firms, employment <500
4.7% of R & D expenditure
28.6% of manufacturing output
32.0% of manufacturing employment
Ratio, share in R & D expenditure : employment share = 0.147

West Germany, 1973: firms, employment <500
2.2% of R & D expenditure
49.9% of manufacturing employment (in 1970)
Ratio, share in R & D expenditure : employment share = 0.044

Israel, 1972–3: firms, employment <100
24% of R & D expenditure
63% of manufacturing output
67% of manufacturing employment
Ratio, share in R & D expenditure : employment share = 0.358

expenditure. As we shall see below, small innovative firms are still with us and, despite increasing industrial concentration, retain an important role in invention and innovation. Moreover, 'more R & D' cannot necessarily be equated with 'more innovation', and size by itself does not guarantee a more efficient R & D/innovation transformation process.

Finally, with respect to the question of R & D and firm size, it is worthwhile mentioning here an ongoing project at the Sussex European Research Unit on the dynamics of innovation in the electro-optics, electronics process control and analytical instruments industries in Europe and the US. This research has shown that in all three industries, because of very high rates of technological change, the threshold level of R & D effort necessary to stay in the innovation race is rapidly increasing. This process is at its most advanced in the US, especially in the electro-optics industry in which the US is technologically ahead of its European competitors. The process of increasing R & D thresholds has led, both in the US and Europe, and in all three industries, to small firms increasingly seeking co-operation with larger companies to enable them more rapidly to exploit their inventions. This is resulting, most notably in the US, in the formation of strong oligopolies. It is worth adding that in the electro-optics area, while R & D thresholds are increasing rapidly, because of a preponderance of defence procurement, smaller firms are still competing since defence contracts are covering much of the high R & D costs.

(ii) *Firm size and invention*

Evidence concerning the relative contributions of firms of different sizes to inventive output is limited (for a detailed discussion of this issue see Soete, 1979). Table 4.5 lists the results of several studies on the frequency of major inventions by small firms or independent inventors; it suggests that small firms and independent inventors have played a disproportionately large part in producing major twentieth-century inventions (Prakke, 1974).

Table 4.5 Research on the frequency of major inventions by small firms or independent inventors

Authors	Type of inventions	Percentage of inventions by small firms or independent inventors
Jewkes, Sawers, Stillerman (1958)	61 important inventions and innovations of the twentieth century	(more than) 50
Hamberg (1963)	major inventions in the decade 1946–55	(more than) 67
Peck (1962)	149 inventions in aluminium welding, fabricating techniques and aluminium finishing	86
Hamberg (1963)	7 major innovations in the American steel industry	100
Enos (1962)	7 major inventions in the refining and cracking of petroleum	100

Source: Prakke (1974).

Re-analysis of the Jewkes, Sawers and Stillerman (1958) data listed in Table 4.5 showed, however, that while universities, independent inventors and small firms made the major contribution to the more radical type of twentieth-century invention before 1930, since 1930 corporate R & D has played the dominant role (Freeman, 1967). It is also worth noting that at least half the inventions in the sample produced by small firms and independent inventors subsequently owed their successful commercial exploitation to the development work and innovative efforts of large firms.

Data from the United States show that smaller firms produce a much higher – although declining – number of patents per dollar of R & D expenditure than large firms (Table 4.6) which has been claimed as evidence of superior productivity of smaller firm R & D. However, one leading expert in the United States provides evidence that, contrary to general belief, large US firms have a lower propensity to patent than small firms (Schmookler, 1966). In his view small firms cannot afford not to patent, and cannot afford to wait, so that patent statistics tend to exaggerate the contribution of small firms to innovative output. (Merely counting patents does not, anyway, given any indication of their relative importance.)

Table 4.6 Estimated invention rate for major inventions per R & D dollar* in the US

Time interval	Firm size (total number of employees)		
	1–1,000	1,000–10,000	10,000+
1953–9	100	29.5	3.9
1960–6	64.4	14.4	2.2
1967–73	35.1	9.0	2.0
1953–73 Total	57.3	15.0	2.4

* Numbers are relative to the invention rate for companies of 1 to 1,000 employees in the 1953–9 period; this rate is assigned the value 100.
Source: Prakke (1974).

Shimshoni (1970) has produced interesting evidence on the contribution of individuals to the generation of inventions in the US instruments industry. He demonstrated that the movement of scientists from one organization to another represented an efficient way of generating instrument inventions and innovations. Of particular interest here is the fact that Shimshoni ascribed a slow-down in the rate of innovation in the US scientific instruments industry to a progressive increase in concentration in that industry. Thus: 'in fields where systems can be developed by relatively small groups, large enterprises and a high degree of concentration are not needed for innovation. On the contrary sheer size may retard innovation by reducing motivation and flexibility.'

Freeman's re-analysis of the Jewkes, Sawers and Stillerman data, and the data listed in Table 4.6, suggest that the relative contribution of small firms to invention might vary over time. Further, Shimshoni stressed that individual mobility and invention are significant only where the field of technology is new, the amount of effort needed for development is modest, barriers to the entry of new firms are not formidable and demand increases rapidly. These might all be taken to support the interpretation of technico-economic development suggested in chapter 3, in which small firms and entrepreneurship play a particularly important role when the technology is new and fluid, and when markets are expanding rapidly, but that their role decreases as the technology and the industry mature.

It is important to note here that the mobile scientist in Shimshoni's study often derived from a large laboratory or large team working on a big project. This highlights the interrelationship between large and small firms, and supports an argument for a dynamic and complementary relationship between the two.

Finally, moving now to firms in the largest size range, Table 4.7 shows the results of Soete's analysis of R & D expenditure and patents for 130 of the largest firms in the US (firms with employment of more than 25,000) (Soete, 1979). These data indicate that:

> . . . with the increase in firm size, firms tend to carry out proportionately more R & D, but at the same time tend to patent less. The figures . . . even suggest that their 'relative' patenting activity or R & D productivity in terms of patents declines dramatically with the increase in firm size.

Thus, Soete's findings on patent concentration ratios conform to those of Scherer (1965), while his R & D concentration ratios indicate an opposite tendency, with R & D concentration ratios on average higher than the corresponding employment ratios.

(iii) *Firm size and innovation*

Probably the most comprehensive body of data on the issue of firm size and innovation is that contained in the innovation data bank at the Science Policy Research Unit at Sussex University. This data bank contains details of some 2,100 important innovations introduced by UK firms between 1945 and 1980, including the size of the innovating firm and of the innovating unit (e.g. subsidiary, central laboratory, separate division) where these are different.

Aggregated data from some thirty-five industry sectors are given in Table 4.8, which shows innovation by size of innovating unit and by size of firm for three separate periods between 1945 and 1980.

Table 4.7 Concentration of patents, R & D expenditure, and employment and various inventive activity intensity measures for the more than 25,000 employees firms, ranked by employment

Number of firms included	Percentage of all 130 firms			Number of patents per $ bill. sales	R & D sales (in %)	Number of patents per $mill. R & D
	Patents	Employment	R & D			
First 4	9.04	23.98	24.13	11.86	2.69	0.441
First 8	19.89	34.62	38.39	17.96	2.94	0.609
First 12	25.91	40.84	43.87	20.17	2.90	0.695
First 16	35.21	45.98	51.61	20.06	2.50	0.803
First 20	40.71	50.39	54.50	21.41	2.44	0.879
First 30	53.13	59.28	63.88	24.47	2.50	0.978
First 40	58.31	66.25	69.69	23.03	2.34	0.984
First 50	64.81	71.93	75.11	23.55	2.32	1.015
First 75	78.99	83.87	78.75	23.17	2.14	1.085
First 100	91.08	92.77	94.11	22.99	2.02	1.138
All 130	100.00	100.00	100.00	23.03	1.96	1.176

Source: Soete (1979).

Taking first innovation by size of *firm*, we can see that for the two earlier periods (1945–59 and 1960–9) SMEs' share in innovations remained remarkably constant, as did that for firms in the size bracket 500–999. At the same time the share of firms in the size range 1,000–9,999 decreased by about 5 per cent, while firms in the largest size category increased their share by about the same amount. Between 1970 and 1980 small firms and firms in the largest size category both increased their share by approximately 5 per cent; the share enjoyed by firms in the 200–499 employment category increased slightly, while the shares of firms in the two categories 500–999 and 1,000–9,999 decreased significantly. Thus, we see that SMEs' share in innovation held up remarkably well between 1945 and 1969 at just under 20 per cent and increased to nearly 25 per cent between 1970 and 1980. Some care must be taken in interpreting this increase, however, since the 1970–80 sample contains a higher percentage of instrument and textile machinery innovations, areas in which small firms have performed more than averagely well in innovation during this period.

Turning now to innovation by size of innovating *unit*, we can again see some interesting changes in shares in innovation during the most recent period. Between 1945 and 1969 the small and medium-sized units (SMUs) share in innovations remained more or less stable (at about 33 per cent), as did the shares enjoyed by the units in the other size

Table 4.8 No. of innovations by size of innovating unit, and by size of firm, for three time periods between 1945 and 1980 in the UK. The data are for important innovations introduced by UK firms.

Time period	Size of enterprise										
	1–199		200–499		500–999		1,000–9,999		10,000+		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Innovation by size of innovating unit											
1945–1959	103	19.5	76	14.4	56	10.6	213	40.3	81	15.3	529
1960–1969	153	18.2	120	14.3	97	11.6	351	41.8	118	14.1	839
1970–1980	241	30.7	109	13.9	113	14.4	255	32.4	68	8.7	786
Total	497	23.1	305	14.2	266	12.3	819	38.0	267	12.4	2,154
Innovation by size of firm											
1945–1959	63	11.9	37	7.0	27	5.1	162	30.6	240	45.4	529
1960–1969	101	12.0	50	6.0	43	5.1	210	25.0	435	51.8	839
1970–1980	132	16.8	59	7.5	23	2.9	119	15.1	453	57.6	786
Total	296	13.7	146	6.8	93	4.3	491	22.8	1,128	52.4	2,154

Source: Townsend, Henwood and Thomas; SPRU innovation data bank, 1981.

categories. Between 1970 and 1980, SMUs' share increased to about 45 per cent of the total, while the shares obtained by units in the top two size categories both declined considerably. Moreover, while the total number of innovations declined from 839 in the 1960–9 period to 786 in the 1970–80 period, the actual number produced by units in the smallest category increased (from 153 to 241). Indeed, the share of innovations by the smallest units increased by a full 12 percentage points between 1970 and 1980.

Thus, in terms of numbers of important innovations, SMEs in the UK have performed rather well during the post-war era, and might have even increased their relative innovative performance during the past decade. The smallest size units have similarly performed remarkably well, again especially between 1970 and 1980. Thus, as industries in the UK have become increasingly concentrated, and as the very large firms have enjoyed an increasing share of total innovative activity in the UK, during the past decade at least their innovatory activity has shifted significantly into relatively small units.

Moving now to more disaggregated data, Table 4.9 shows innovation by firm size for the same three time periods and for six industries separately. We can see that for pharmaceuticals, general chemicals and aluminium production, SMEs' role in innovation has been either zero, or very small and that in pharmaceuticals and aluminium production innovatory activity has increasingly become concentrated in very large firms. During the same period, production in these industries has become concentrated in fewer and fewer large companies and average firm size has increased. In all three areas, capital and development costs are considerable.

In the case of scientific instruments, while SMEs' share in innovation fell by about 5 per cent between the first period and the second, it has since remained constant at around 41 per cent. Moreover, while small firms' share in innovation in this area was 29.1 per cent between 1960 and 1969, their share in net output in 1963 was only 23 per cent. It is, however, firms in the largest size category that have enjoyed the most marked increase in share in innovations, which probably reflects an increase in concentration in this industry. As Shimshoni (1970) demonstrated, scientific instruments is an area in which individual entrepreneurship and small firm innovation is possible. It is an area of relatively low entry costs, and high skill intensity, with many specific opportunities for small specialist companies. It is, perhaps, hardly surprising then that small firms have stood up rather well as innovators during the post-war period.

In electronics computers between 1945 and 1969, innovative activity (and output) was dominated by large firms. During the past decade, however, SMEs have emerged as a significant force and accounted for 40 per cent of all the important innovations introduced in the UK. This is an indication of the emergence of new small firms in this area producing mini- and micro-computers and peripherals based on the use of integrated circuitry. These are highly skill-intensive, require less capital investment than previous models and have opened up a great variety of market niches suitable for exploitation by specialist SMEs.

In the textile machinery industry we can see that innovative output has become increasingly concentrated both in firms in the smallest size category and those in the largest category, the most significant shift being in the latter. To some extent this reflects a pattern of take-overs and mergers with the emergence of a number of large conglomerates. It probably also reflects the fact that innovation in textile machinery has become increasingly radical in nature and has been associated with the presence in the firm of a formal and comprehensive R & D facility, generally contained in only the largest companies (Rothwell, 1976). At the same time a number of innovative small firms appear to have emerged either as suppliers to large companies or as manufacturers of specialist equipment for specific market segments.

Thus, from the above data, we can conclude that SMEs have consistently played an important role in innovation in the UK during the post-war era. On average, their share in innovation has been considerably higher than their share in total (formal) industry-funded R & D. The relative contribution of SMEs to innovation varies a great deal, however, from sector to sector. Generally speaking, in the capital intensive industries, and in those industries in which R & D costs are very high (e.g. chemicals and pharmaceuticals), innovations have been concentrated in large firms. Small firms have made their major contribution in areas such as instruments and machinery where capital intensity and development costs are generally low, and where entry costs for new firms are also low. As we saw in the computer industry, moreover, SMEs are quick to take advantage of new possibilities emerging as the result of technological change and new market opportunities. Thus, while one type of technology – i.e. that requiring high development costs and large investment for realization – can pose a barrier to small firms, other types of technology can provide them with many new opportunities.

A second study, this time of 380 important innovations produced in five countries, and which were introduced on to the market between 1953 and 1973, also looked at the relative contributions made by firms of different sizes to the total number of innovations (National Science

Table 4.9 Innovation by firm size for three periods between 1945 and 1980 in the UK for six separate SIC groups

	1–199		200–499		500–999		1,000–9,999		10,000+		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Pharmaceuticals (SIC 2,720)												
1945–59	0	0	1	4.2	–	–	9	37.5	14	58.3	24	29.3
1960–9	1	3.0	0	0	–	–	3	9.1	29	87.9	33	40.2
1970–80	0	0	0	0	–	–	1	4.0	24	96.0	25	30.5
Total	1	1.2	1	1.2	–	–	13	15.9	67	81.7	82	100
General Chemicals (SIC 2,710)												
1945–59	–	–	–	–	–	–	–	–	–	–	–	–
1960–9	–	–	–	–	0	0	1	33.3	2	66.7	3	25
1970–80	–	–	–	–	2	22.2	1	11.1	6	66.7	9	75
Total	–	–	–	–	2	16.7	2	16.7	8	66.7	12	100
Textile Machinery (SIC 3,350)												
1945–59	4	12.9	7	22.6	8	25.8	11	35.5	1	3.2	31	31
1960–9	17	22.1	12	15.6	18	23.4	22	28.6	8	10.4	77	34.4
1970–80	35	30.7	9	7.9	6	5.3	12	10.5	52	45.6	1114	51.4
Total	56	25.2	28	12.6	32	14.4	45	20.3	61	27.5	222	100

Aluminium Prod. (SIC 3,210)												
1945–59	–	–	0	0	–	–	13	92.9	1	7.1	14	35.9
1960–9	–	–	1	5.6	–	–	2	11.1	15	83.3	18	46.2
1970–80	–	–	0	0	–	–	0	0	7	100	7	17.9
Total	–	–	1	2.6	–	–	15	38.5	23	59.0	39	100
Scientific Instrum. (SIC 2,542)												
1945–59	17	36.2	5	10.6	2	4.3	12	25.5	11	23.4	47	14.3
1960–9	25	29.1	10	11.6	0	0	18	20.9	33	38.4	86	26.2
1970–80	57	29.2	24	12.3	2	1.0	32	16.4	80	41.0	195	59.5
Total	99	30.2	39	11.9	4	1.2	62	18.9	124	37.8	328	100
Electronic Computers (SIC 3,660)												
1945–59	0	0	0	0	1	4.2	6	25	17	70.8	24	44.4
1960–9	0	0	0	0	0	0	3	20	12	80.0	15	27.8
1970–80	2	13.3	4	26.7	2	13.3	0	0	7	46.7	15	27.8
Total	2	3.7	4	7.4	3	5.6	9	16.7	36	66.7	54	100

Source: Townsend, Henwood and Thomas, SPRU Innovation data bank, 1981.

Foundation, 1976). The results of this study are presented in Table 4.10. The table shows that:

(a) Averaged over all countries, small firms contributed about one third of all innovations (31 per cent), the majority share being taken by large firms (54 per cent).
(b) Medium-sized firms played only a minor role, except in France, where they contributed 26 per cent of innovations.
(c) Small firms' contribution was highest in the US (35 per cent) and France (31 per cent), followed by West Germany (26 per cent) and the UK (23 per cent).
(d) Small (and medium) firms in Japan played a very minor role as producers of major innovations.

The study also looked at the comparison of firm size with the 'radicalness' of the innovation. The results of this comparison are listed in Table 4.11. They show that:

(a) In the United States small firms produced a reasonably even distribution of 'radical breakthrough', 'major technological shift' and 'improvement'-type innovations (27 per cent, 30 per cent and 37 per cent respectively of all small firm innovations). A similar pattern was found for large firms.
(b) The output of small firms in the UK was entirely composed of radical breakthrough type innovations. The emphasis in large firms was also on this type of innovation (56 per cent of all large firm innovations in the UK).
(c) In West Germany, Japan and France the emphasis for firms of all sizes was on the less radical types of innovations.

It must be stated here, however, that great care is needed in interpreting Tables 4.10 and 4.11 since, outside the US, the data base is extremely limited.

Finally, with regard to firm size and radicality of innovation, a study of fifty or so post-war innovations in the European textile machinery industry has shown that the size of firms producing technically radical innovations was about three times that of firms producing non-radical incremental innovations (750 radical innovators; 220 incremental innovators) (Rothwell, 1976). The radical innovations were associated with the presence in the firm of a formal R & D department and qualified engineers and sometimes scientists. The incremental innovations were associated with a design and development department and non-graduate level technicians.

These data highlight the differences between NTBFs, which tend to be

Table 4.10 Share of 352 major innovations by firm size in five countries

Country	Small firms[1]		Medium Firms[2]		Large firms[3]		Total no. of innovations
	No. of innovations (Ns)	Ratio Ns : Nl	No. of innovations (Nm)	Ratio Nm : Nl	No. of innovations (Nl)	Ratio Nl : (Ns + Nm)	
US	90 (35%)	0.70	37 (15%)	0.29	129 (50%)	1.02	248
UK	8 (23%)	0.35	3 (8%)	0.13	23 (67%)	2.09	34
West Germany	5 (26%)	0.42	2 (10%)	0.17	12 (64%)	1.71	19
Japan	1 (4%)	0.05	4 (16%)	0.20	20 (80%)	4.00	25
France	5 (31%)	0.71	4 (26%)	0.57	7 (43%)	0.78	16
Total	109 (31%)	0.57	50 (14%)	0.26	192 (54%)	1.20	352

[1] Sales less than $5 million.
[2] Sales $5 million to $50 million.
[3] Sales greater than $50 million.
Source: NSF (1976), Reference 20.

Table 4.11 Firm size and radicality of innovation

Firm size and country	Radical breakthrough		Major technological shift		Improvement		Imitation		No. new technology	
	No.	%	No.	%	No.	%	No.	%	No.	%
United States										
Small	25	27	27	30	34	37	0	0	4	4
Medium	8	21	11	29	15	40	1	2	2	5
Large	30	24	33	26	48	39	1	0	11	8
UK										
Small	8	100	0	0	0	0	0	0	0	0
Medium	0	0	3	100	0	0	0	0	0	0
Large	13	56	8	34	8	0	0	0	0	0
West Germany										
Small	1	20	2	40	2	40	0	0	0	0
Medium	0	0	1	50	1	50	0	0	0	0
Large	2	16	6	50	3	25	1	8	0	0
Japan										
Small	0	0	1	100	0	0	0	0	0	0
Medium	0	0	1	25	3	75	0	0	0	0
Large	2	10	11	54	6	30	0	0	1	5
France										
Small	1	20	3	60	1	20	0	0	0	0
Medium	1	25	3	75	0	0	0	0	0	0
Large	1	14	5	71	1	14	0	0	0	0

Source: NSF (1976), Reference 20.
Small firms – sales less than $5 million.
Medium firms – sales between $5 million and $50 million.
Large firms – sales greater than $50 million.

started by technical entrepreneurs and which seem successfully able to produce major innovations, and small firms in traditional areas. The latter, used primarily to a regime of incremental technical change that is often user-stimulated, simply do not possess sufficient in-house technical expertise to enable them to cope with major technological shifts. In such cases, comparative advantage appears to shift markedly in favour of the larger R & D performing firms. The changes in technology might, however, provide an opportunity for new entrants, and create possibilities for existing small firms in specialist market niches.

The Canadian study (de Melto *et al.*, 1980) referred to earlier also addressed the question of innovation and firm size. In a novel approach, rather than counting the number of innovations by firms of different sizes, they looked at the type of innovation (product or process) and the novelty of the innovation (new or imitative). With respect to the former they found that the

> relative product/process orientation of small and large firms shows some variation at the industry level. Larger firms in the telecommunications equipment and plastics compounds and synthetic resins industries are clearly more process innovation oriented than are small firms. Very few firms of any size produce process innovations in the electrical industrial equipment industry, and in crude petroleum production, almost all of the reported innovations are process innovations. In the smelting and refining industry, large firms are actually more product-oriented than are small firms, a reflection of the fact that the large smelting and refining firms are more diversified in terms of their overall activities.

Moving to the question of the proportion of new and improved innovations by size of firm, De Melto *et al.* found no clear trend with firm size. When, however, firm size was further characterized by control (Canadian-controlled vs. foreign-controlled), several differences did emerge:

> Very small and larger Canadian-controlled firms tend to produce a higher proportion of original innovations than do foreign-controlled firms of these sizes. On the other hand, for medium-sized firms (51–200 employees), this tendency is reversed. As we have seen earlier, the acquisition of technology for innovations from a source external to the firm explains the general tendency for foreign-controlled firms to produce higher proportions of imitative innovations.

Finally, Piatier (1980) has reported the results of several comprehensive studies in France concerning the attitudes of managers to the creation of new products and to the improvement of existing products, and how these attitudes vary with size of firm. In general, the tendency to consider the creation of new products as a prime objective increased with size of firm, while the reverse tendency existed concerning the introduction of product improvements.

4. Small firms and new technology: the case of microelectronics

The one emerging technology which many believe will have a major impact on SMEs is microelectronics, and opinions as to the effect of microprocessors on the comparative advantage of SMEs *vis-à-vis* large firms are mixed.

One commentator states (Stroetman, 1978):

> New or improved products incorporating them are now on the market such as smart video games, electronic watches, smart scales and so on. Hierarchical computer systems to control complicated production processes become feasible, and *for small businesses new markets open up.*

He then adds:

> At the same time, many small companies producing mechanical components and devices are threatened unless they can adapt to this new technology or develop new products for different markets.

A second observer, the author of a recent report on the impact of microelectronics on manufacturing industry, states (Maclean, 1978):

> . . . in general, I do not think the advent of the microprocessor really creates new opportunities for small/medium firms. For sure, microprocessors are cheap, but the ability to use them properly (and profitably) depends on making a fair sized investment (a design team of half-a-dozen people usually).* A key factor here is the availability of appropriately skilled people and, outside the electronics business itself, there are few small firms that can afford to acquire the scarce (and therefore expensive) personnel to have a go at using microprocessors. . . . In general the best set-up for exploiting the new micro-electronic technologies is to be part of a big diversified firm (like GEC) which already has access to the right kind of skills. This works especially well in countries and regions (i.e. California and Japan) where such skills are relatively abundant. All in all, I think that big firms will do better out of this wave of technical change.†

Finally, from the US (*Business Week*, 1976):

> Development time is so short for a smart product now and the entry costs are so low that there will be myriad examples of new companies spawning, with bright young fellows developing microprocessor-based products.

It is interesting that the first two comments above, which derive from European sources, discuss the impact of microprocessors on *existing* SMEs, while the latter comment, from the US, focuses on the role of microprocessors in generating *new* technology-based small firms.

* The setting up of a new R & D laboratory represents a substantial risk for small firms. This might constitute a considerable entry barrier for SMEs wishing to exploit properly microelectronics.

† Private communication. The report mentioned is Maclean (1978).

In terms of the application of microelectronics in manufactured products, a recent report in the UK has highlighted the problems faced by small firms (Northcott, 1980):

> For small firms in industries not previously related to electronics the lack of relevant in-house technical expertise must often present daunting problems. With no one on their staff who is at all familiar with the new technology it may be a long time before anyone realises there could be possible applications to their products, and even when someone in the firm does get the idea that maybe this is a question they should be looking into, they might be quite perplexed as to what they should do to get started in this strange new world . . . Most firms see the lack of sufficient people with particular kinds of expertise as a serious problem . . . The lack most previously mentioned is that of electronics engineers with sufficient software experience to enable them to undertake the design of new products.

In terms of the application of microprocessors in manufacturing processes, the report later states:

> Many protential users of microprocessor controlled equipment are small and lack the expertise or funds to develop possible applications on a one-off basis. It is therefore likely that the main impetus to the development of applications will come from the manufacturers of the plant, except in industries where there are large and technologically sophisticated users.

A similar view is held by Schenk (1981), based on his survey of the structure of the producer and user industries in Austria:

> . . . the international semiconductor industry tends to concentrate its efforts upon the few larger clients in Austria; cooperation with the many small and medium-sized users (estimated to be 400 in number in 1980) and potential users appears to be rather superficial in general, if it exists at all. There are sound economic reasons for this attitude of the semiconductor industry. The semiconductor manufacturers themselves have been running short of personal and financial means of catching up with rapid technical progress and find it now difficult to supply training and application assistance to their customers. In particular, cooperation with users who have no experience in microelectronics or even electronics can be a very troublesome, labour-intensive, risky and costly operation, and since there is no big market behind it, the semiconductor manufacturers shy away from this kind of business. As a consequence, many smaller Austrian firms in the

> engineering industries find it difficult to use the new technology for improving their competitiveness and larger firms have been quicker, on average, in the application of micro-electronics.

Thus, many small and medium-sized Austrian firms appear to be unlikely to succeed in incorporating microelectronics into existing production systems. Schenk further sees that, even with 'ready-to-use' systems purchased from outside, some in-house expertise in application technology is necessary. Small firms, however, have reported severe problems in hiring skilled engineers and technicians. Almost all Austrian electronics graduates have, during recent years, been absorbed by a few big companies.

For small firms within the electronics industries the process of adjustment to the use of microprocessors appears, as might be expected, to be rather easier. According to Senker and Arnold (1980): 'Smaller firms recruiting experienced design engineers without knowledge of microprocessors said that there was no great problem in training such engineers "on the job" to design with microprocessors. One small microcomputer manufacturer has employed minicomputer designers without experience of designing with microprocessors.'

Senker and Arnold do, however, point to potential problems for small firms in the availability of suitably skilled engineers.

Turning finally to the microelectronics industry itself, while the emergence of integrated circuitry undoubtedly created opportunities for relatively small new entrants, this phase appears to have passed. Bessant (1981), describing structural changes in this industry during the past fifteen years or so, states:

> The second important trend is to the entry of major multinational firms and to joint ventures. Closer analysis reveals considerable restructuring . . . (it) indicates the change in the US electronics industry over the past fifteen years, with the decline of 'traditional' manufacturers and the emergence of small innovative ventures. The next stage appears to be the 'buying in' (for example Exxon's Zilog) or as takeovers (like United Technologies' purchase of Mostek or Schlumbergers' of Fairchild). Joint ventures – particularly in Europe – include the recently announced Matra-Harris/Intel deal (which will involve an estimated $40 million of French government support).

A similar trend towards joint company and/or joint company–government ventures is apparent also in Japan and in the UK. The point is, the costs involved in microelectronics manufacture are now enormous (see Table 4.12), and the overall pattern is of increasing entry costs. Thus,

Table 4.12 Typical costs for semiconductor manufacture

Year	Product	Volume	Investment cost
1980	16K RAM	2.5m/year	$8.5 m.
1982	64K RAM	2.5m/year	$18 m.
1985	256K RAM	2.5m/year	$40 m.

Source: J. Bessant, 1981.

the day of the relatively small new venture entrant in the integrated circuit industry appears to have been rather short-lived, and any advantage small firms might gain from this new technology are now likely to derive from its imaginative use in the development of innovative new products, rather than from the manufacture of the devices themselves.

Finally, in rounding off this chapter, we would like to emphasize that the issue of innovation by firm size – which is, of course, a highly important one for public policymakers – is not to do with the question of 'big firms' *or* 'little firms', but rather with discovering the appropriate dynamic balance between the two. The optimal balance will be different for different phases in the industry cycle; it will vary with technology and with markets. The point is, this balance can be upset by a variety of imperfections in the market place such as overweening monopoly power, and it is the function of policymakers, via a whole range of measures available to government, to attempt to restore the appropriate competitive dynamic. In most areas there exists a complementary relationship between the small and the large which acts to the benefit of both. Public policy should be aimed towards enhancing this synergistic relationship and resisting those forces tending to destroy it. Moreover, since SMEs have in the past played a significant role in innovation (and continue to do so today), and given that the social rate of return on innovation often outweighs the private (Mansfield, 1981), then this offers further justification for public intervention in this area. This issue will be dealt with in greater detail later in this book.

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5 CHARACTERISTICS OF NEW ENTREPRENEURSHIP

Introduction

A major theme in the innovation literature over the past years is the importance of small firms, and especially new small firms, in the process of technological innovation. In the discussion on this theme emphasis is put on the aspect of 'newness' in the Schumpeterian sense, as well as on 'smallness' and 'technical innovativeness'. As we saw in chapter 4, a number of investigations have shown evidence that new and small firms have accounted for a very large portion of especially the fundamental innovations during this century. For the large scale development of these fundamental innovations, however, large corporations have been of importance. The results of these investigations disagree with the once popular belief, and the opinions voiced by Schumpeter and Galbraith, that technical innovation would increasingly become the domain of large industrial laboratories. The current innovation discussion is characterized by a large degree of enthusiasm for the innovative potential of the small and new firms. This enthusiasm is supported by economic, popular, cultural and philosophical arguments.

From a standpoint of economic efficiency, attention is often pointed to the organizational flexibility and the market orientation of small firms. Large firms are sometimes accused of withholding certain innovations for monopolistic reasons. The data in chapter 4 showed it to be the case that in some industrial sectors, large corporations are relatively less effective on the basis of certain measuring sticks for innovative performance, such as patents and new products.

A much-cited example of dynamic efficiency of small firms is the development of the semi-conductor technology in the United States (chapter 3). This development did not primarily take place at the 'obvious', best equipped, large producers of radio tubes like RCA and GE, but at the then small and new firms like Motorola, Texas Instruments and Fairchild. Carlson, the inventor of the Xerox copying machine, did not succeed in selling his invention to Kodak and IBM, both large, well established firms.

Currently, there are signs that the most promising developments in DNA technology in the United States do not, or do not only, take place within large chemical and pharmaceutical firms, but also within a number of small firms, closely collaborating with universities and risk capital institutions. Table 5.1 shows a number of examples of the contributions of independent inventors and small organizations to major twentieth-century inventions.

Table 5.1 Some important inventive contributions of independent inventors and small organizations in the twentieth century

Invention	Inventor	Invention	Inventor
Xerography	Chester Carlson	Jet engine	Frank Whittle/ Hans von Ohain
DDT	J. R. Geigy & Co.	Frequency modulation radio	Edwin Armstrong
Insulin	Frederick Banting	Self-winding wristwatch	John Harwood
Vacuum tube	Lee De Forest	Continuous hot strip rolling of steel	John B. Tytus
Rockets	Robert Goddard	Helicopter	Juan De La Cierva/ Heinrich Focke/ Igor Sikorsky
Streptomycin	Selman Waksman	Mercury dry cell	Samuel Ruben
Penicillin	Alexander Fleming	Power steering	Francis Davis
Titanium	W. J. Kroll	Kodachrome	L. Mannes and L. Godowsky Jr.
Shell moulding	Johannes Croning	Air conditioning	Willis Carrier
Cyclotron	Ernest O. Lawrence	Polaroid camera	Edwin Land
Cotton picker	John & Mack Rust	Heterodyne radio	Reginald Fessenden
Shrink-proof knitted wear	Richard Walton	Ball-point pen	Ladislao and Georg Biro
Dacron polyester fibre 'Terylene'	J. R. Whinfield/ J. T. Dickson	Cellophane	Jacques Brandenberger
Catalytic cracking of petroleum	Eugene Houdry	Tungsten carbide	Karl Schroeter
Zipper	Whitcomb Judson/ Gideon Sundback	Bakelite	Leo Baekeland
Automatic transmissions	H. F. Hobbs	Oxygen steel-making process	C. V. Schwarz/J. Miles R. Durrer
Gyrocompas	A. Kaempfe/ E. A. Sperry S. G. Brown		

Source: Technological Innovations: Its Environment and Management, United States Department of Commerce, Washington, 1967.

Advantages attributed to small or new firms in this respect are that they are less bound to follow traditional methods of problem-solving, and that they invest less in production equipment. Some investigators are considering the ability of small new firms to find new combinations of technico/economic importance of great value in periods of prolonged stagnation. In this view entrepreneurs and small firms can be seen as a 'genetic reservoir' from which the successful technico/economic combinations of the future can be selected.

Shapero, in his many writings on the subject of entrepreneurship, combines the above with the consideration that a high level of small scale entrepreneurial activities is a relatively inexpensive way for society to seek solutions to problems in a situation that is characterized by great uncertainty. We recognize here a rule of systems theory, namely that 'only variety can destroy variety'. In chapter 3 we emphasized the role that small and new firms play in the first phase of the life cycle of a technology. This is the phase in which great uncertainty exists, both with respect to technical potential and to commercial application.

Next to a positive effect of dynamic efficiency, small and new firms appear to contribute remarkably to employment stability in the present phase of economic stagnation. For example, during the period 1970–75, 190,000 jobs were lost in industry in the Netherlands; of this number only 5,000 were lost in firms with less than 500 employees. For the US, Birch (1979) calculated that during the period 1969–76 two-thirds of all new jobs were generated in firms with less than twenty employees; 80 per cent of these jobs were realized in firms less than five years old. Conclusions for the manufacturing sector, however, should not be exaggerated, since the largest part of these new jobs were created in the service sector including the retail trade. For industry, nevertheless, the employment effect of small firms appears, in contrast to the situation in large firms, to be generally positive. In absolute numbers, however, the effect of new and small firms on employment is, at least in the short term, relatively low (*Economist*, 26 January 1980). The issue of the role of the smaller firm in employment operation is discussed in detail in chapter 7.*

From a standpoint of regional economic development, there is also growing support for new innovative firms. The results of traditional regional development policies, mainly attracting branch plants from the economic centres in accordance with growth-pole theories, are proving ineffective in times of recession. Independent innovative firms are expected to take a more positive regional stand and will thereby contribute to the local industrial ecology (see chapter 8). It is interesting to consider the special vulnerability of highly specialized industrial cities and regions

* In terms of economic regeneration, it is important that the human resources freed through the process of rationalization in large firms should be redeployed contructively elsewhere in the economy. Thus, via entrepreneurship, the imbalance in the economy created by overweening concentration in often stagnant industries can be righted.

versus the greater resilience of local and regional economies that contain large numbers of small firms. Contrasting Manchester and Birmingham in the mid nineteenth century, Jane Jacobs (1969) sought clues to long-term community dynamism. She pointed out that knowledgeable writers of that time described Manchester as an example of efficiency and a model of the future.

At that time, Britain dominated the world in textiles and Manchester, located close to the port of Liverpool, was at the heart of Britain's textile industry. Coal, pure water and a humid climate, gave Manchester the necessary comparative advantages. Manchester had acquired the efficiency of a company town. Birmingham, on the other hand, had retained something different; a high rate of innovation. More jobs, more income, regional exports and a substantial contribution to Britain's GNP were not enough to sustain Manchester over a long period of time.

A more useful approach to economic development is to identify the dynamic qualities that differentiate communities that are self-renewing over time, despite technological and economic change, from communities that are not. The qualities that have distinguished Birmingham from Manchester are: resilience, creativity, initiative-making and, above all, diversity. Entrepreneurship, as measured by company formations, is a positive response to the environment. A programme for encouraging entrepreneurial formations can therefore be considered a low risk, high potential-gain strategy, because a society or community with a high level of entrepreneurship ultimately incurs less risk than one that relies upon the illusory security of large scale enterprises.

It is clear that on populistic grounds, fully market-dependent small new firms are receiving generally more sympathy than the power concentrations that large corporations represent. In this respect it is remarkable that there is growing political appreciation for small industrial firms by the Communist parties in France and Italy. In the United States, a country with a strong populistic tradition, the Small Business Administration strongly supports small firms.

Finally, the rediscovery of the importance of the entrepreneurial small firm fits well with the cultural-philosophical thinking of our time. Schumacher (1973), with his 'Small is Beautiful', contributed a great deal to this movement. While it was assumed for a long time that economic growth and industrialization were strongly connected with large scale operations, a certain reconsideration is now taking place. The concept of 'human size' is being introduced as a norm in the evaluation of what industrialization has produced in terms of social structures and technology. There is a growing demand for courses in entrepreneurship and management of small firms. In the US more than 200 universities are presently offering such courses.

The entrepreneur and his environment

Since the establishment of a new innovative firm can be regarded primarily as an individual action, we will first discuss personality factors and the attitudes of technological entrepreneurs as derived from a number of studies.

Roberts (1969), in the 1960s, studied more than 200 'spin-off' companies in the Route 128 area around Boston, that were established by independent entrepreneurs who came from a number of large universities and government or private laboratories in the area. The firms investigated were of an average age of four to five years. Only one-fifth of the investigated firms disappeared during these first four to five years, a relatively low percentage, which could well be attributed to the then prevailing favourable market conditions, notably the high level of procurement and R & D funding by NASA. Thirty-two investigated spin-off firms of a single large parent company between them had a turnover of twice the volume of the parent company. Most of the investigated firms began as subcontractors to government aerospace and defence projects. After a period of four to five years, however, 40 per cent of the turnover of the new firms was generated in commercial non-government markets.

As to the characteristics of the technological entrepreneur, Roberts found that a relatively high percentage had a father who had been an independent businessman. The average educational level of the new entrepreneurs was a bachelor's degree, many of them possessed a master's degree, but only a few of them had a Ph.D. Before starting on their own, entrepreneurs who came from the Lincoln Laboratory had spent two and a half years in industry to obtain the necessary commercial experience.

Litvak and Maule (1975), in a Canadian study, pointed to the fact that many technological entrepreneurs started a firm several times and that the firms that failed were to a large extent 'first starts'.

A. Pearson (1979) described the essential characteristics of the new small firm: however many employees it may have at start-up or later in its successful growth, it is a highly personalized enterprise and, the smaller the company, the more the problems receive personal treatment. Small firms are distinguished not so much in that in comparison with large companies they have a lower turnover, capital and number of employees, but by the fact that they are managed by proprietors who work in the company and bear the entrepreneurial risk.

The entrepreneur, as the founder-owner-manager, can be a relatively isolated individual. He bears the responsibility of gathering information, assessing it and making the decisions regarding all aspects of the company business, including finance, marketing, production and product development. He has started his own manufacturing operation with a new idea, product or market opportunity, identified when working with a previous employer or in some other way. His base of expertise is usually a narrow one. He is wholly involved, caught up in day-to-day problems, and yet simultaneously having to deal with policy problems. He works under fierce time constraints and for long hours. If information is not available virtually immediately, he does without, and the problem is arbitrarily solved because he is quickly forced into consideration of other problems.

For a group of British entrepreneurs, Watkins (1976) found that, in comparison to those of Roberts, they had often had a less formal, systematic education. In terms of the factors motivating these entrepreneurs, as Table 5.2 shows, the reasons for starting a firm seem more often of a psychological, rather than of a business nature.

Table 5.2 Self-description of motivating factors for entrepreneurship

Rank		Percentage*
1	Desire for independence	35
2	Desire for increased job satisfaction	25
3	As a release for creative urges	13
3	Financial motivation	13
5	Enjoy exploiting business opportunities	11
6	Commitment to product/service, Desire for power, Others	3
		100

* Percentage of people listing factors as most important.
Source: Watkins (1976).

Shapero (1971) not only investigated technologically innovative firms, but also individual entrepreneurship in general. Many of Shapero's findings are of great importance and of direct relevance to this chapter. Based on empirical studies of entrepreneurship in, among others, the US, France, Italy, India and South Africa, Shapero has identified four major factors that determine the company formation process, namely:

Displacement: some event whose impact on the entrepreneur precipitates the action.
An apparent disposition to act on the part of the nascent entrepreneur, an individual phsychological propensity.
Credibility: the act of forming a company is made credible by example, or is socially acceptable in the local culture.
Availability of resources which make the act economically and technically feasible.

Whereas 'disposition to act' is primarily of a personal nature, 'credibility' and 'resources' are more of an environmental nature, with 'displacement' containing elements of both. The four factors together encompass the entrepreneurial function. They are discussed below with quotations from both Shapiro (1980) and Prakke (1980).

Displacement

> Consider if you will someone in a given path in life, held in place by all kinds of vectors, directional forces. Many people talk about starting businesses someday, but few do. Many forces hold us in place; the children are small, the wife is taking a degree, the elderly mother is in a nearby town and, the biggest factor of all, inertia, the force of just following a path in life that isn't so painful, all keep us on a given path. During World War II when the gates of the concentration camps were opened it took time for people to walk out the gate, because the inertia of what they had known was so very powerful. (Shapero, 1980.)

In Europe, more than in the US, a long tradition of a life-long career or skill, strengthened by job security, has reinforced the inertia of remaining on a path that is not so painful or disruptive as launching into self-employment. A stimulating event is required to precipitate action. This event, which is strictly personal in its impact, has been described by Shapero as displacement.

> The formation of a company is a distinct, discrete event that requires explicit legal, financial and organizational actions on the part of its founders. Yet of the many company formations studied, seldom are any found that resulted from a rational, calculated, carefully planned succession of decisions and actions . . . Most company formations are associated with some kind of personal displacement, some dislodgement from a comfortable or otherwise acceptable state of being. Some other formations are initiated during a period when the founder is

> out-of-place between things, not yet lodged in an acceptable state. (Shapero, 1980.)

Displacements that initiate the company formation process can be negative, externally imposed (or a push) or positive, internally imposed (a pull).

External push

> The biggest form of displacement is external, where you have no choice. Refugees, the most completely displaced people in the world, have no choice, and refugees are a main source of entrepreneurs. For example, the displaced Vietnamese in the US, Africans in France, Pakistanis in Britain, Palestinians in the Lebanon, East Germans in West Germany, Cubans in the United States who transformed the economy of Florida. The Vietnamese in the US, I am convinced, were rolling egg roll before they got off the aeroplane. Another marvellous source of external displacement is getting fired. One of the tragedies in Europe is that social progress does not let you fire anyone, for being fired is a big source of companies. As a matter of fact we once found that in a group of consultants, 80 per cent of those present started out as consultants by being fired. (Shapero, 1980.)

A work-related push is *transfer*:

> For example, someone doesn't want to be transferred, to leave his home town and go to work in another town. It happens very often in big corporations, especially where they have well developed manpower plans. They say 'You are a marvellous salesman, you have done a marvellous job so we are going to do you a favour. We are going to send you to Sicily', but you say 'I don't want to go. I'll stay here. I won't take a raise'. 'No, our plan calls for you to go there, and for John to come here.' Many people who are transferred do not want to go. Or the son in a family firm finds that he is thirty-eight years old, and his father will not let him make a decision yet, thinking that he is not ready. Very often, in countries with a lot of family firms, this is a high source of new companies, because the son is like the father, and starts a company. (Shapero, 1980.)

Frustration

Frustration is a powerful push and, 'the emigration of frustrated men from corporations' has been identified as a prime source of new engineering companies in the UK.

> One of the biggest sources of the technical companies is 'technological frustration' in which a group of engineers first present an idea to the company they work for, saying 'Let's make this marvellous thing', and the company says No! Don't rock the boat. Don't do it, or the company management says it won't work (and, by the way, later on the entrepreneur often says you know the company was right, it didn't work). (Shapero, 1980.)

But by then they are committed entrepreneurs, learning by their mistakes, hopefully to achieve later success.

Age

Age can be a factor, a kind of internal displacement. 'I was going to be forty and I had to do it then or never.' The mean age of new starters reported on by Prakke (1980), in his study on new innovative firms in the Netherlands, was thirty-eight years. Moreover, founders of new-technology firms tend to be young, with less than ten years' experience, as against the seventeen years or more of the founder of the more traditional technology-based firms. Further, as Shapero stated,

> There are also people not in place. In the US, many companies were started after the Korean war by people who had been in World War II, had started on their careers, but had stayed in the military reserve and were called back for Korea. Their lives interrupted, many of them stayed on to retire from the military, but another group said, with great wisdom, 'Before I settle down I am going to try it'.

Pull

Shapero has given many examples of pull:

> It often happens to engineers and sales people in manufacturing industry or in services: a customer says, I don't like your boss, he's no good. Why don't you start up a company? I'll give you the contract. The act pulls a person, who may never have thought of going into business, into an entrepreneurial effort. Another form of pull is a would-be partner, a colleague, or a dear friend who says, let's do this thing together. I'm going to do it. I have this contract. Come with me. And so someone who did not think of starting a company is pulled into the act. A third pull is a sudden receipt of funds from a will or a bequest or a lottery, which pulls some to start a company. (Shapero, 1980.)

Disposition to act

While many people are displaced or subjected to some form of pull or push, many of them do not react by forming a company. There are only a few who start on their own; it is these who have a 'disposition to act'. This is the difference between the entrepreneur and the non-entrepreneur. The most probable and dominant factor in the disposition to act is the desire for independence:

> Asked about the reasons for starting out, personal motives were much more often mentioned than business ones. The wish for independence and frustration with the old organisation ranked very high. Similarly, when asked about potential reasons for stopping, the most often heard answer was something like: 'I'll stop when the interference in my business by government becomes too great'. (Prakke, 1980.)

Credibility

Given the desire to be independent, the entrepreneur sets up a new business. But why is this the course of action chosen; why does it seem the most credible action? Credibility is another important factor in the company formation process. It is provided by the examples of others, someone like one's self, with whom one can identify. It is also provided by what can only be described as 'the local culture'.

> In a culture where entrepreneurship is admired the chances of your starting a company are much greater. However, if you are in a culture where starting a business is to lose status, then the likelihood of your starting a business goes down radically. In Italy, I found that a man of education who started a small business lost social status. In the US, that man is a folk-hero. Peer approval is very important – and this is where I have some hard things to say about universities. Universities look down upon small businesses, even while they sometimes study them and acknowledge their value for the economy. There is an intellectual prejudice, going back to the Middle Ages, that holds contempt for men of commerce. Every tradesman would like his son to go to university, to become professional, to work for General Motors, to wear nice suits and be an aristocrat. This prejudice is so profound that I claim there are no schools for business in the US – only academies of corporate middle management. (Shapero, 1980.)

Availability of resources

Indications are that a key factor as to whether an area will generate and keep new enterprises is the existence of local financial, technical and other institutions responsive to new firm creation. In Boston and Atlanta, the technical scientific infrastructure, including the universities, played an important role in stimulating new firms and the banks had a positive attitude towards financing them. In Boston the original markets for new firms' products were government agencies whereas in Atlanta the market was private. In Philadelphia, in contrast to the other two cities, the banks were unreceptive and the universities unsympathetic. Of all the environmental factors influencing entrepreneurship, we will discuss the five most important. These are: the availability of risk capital, the fiscal system, access to technical knowledge, the patent system and the market.

Availability of risk capital

In dividing the development of a firm into a number of phases, from company formation to maturity, it is clear that during the first phases, namely start-up and early growth, the entrepreneur is dependent on his own financial resources and sources. Sometimes supplementary funds are provided through public measures, or by the large organization, sometimes called the incubator organization, where the entrepreneur was previously employed. It is not until the later phases of company development that the entrepreneur has access to the traditional investment funds of banks, the Stock Exchange, profits and, eventually, merger partners. In between lies a period where financing is extremely difficult to arrange. Since the availability of adequate sources of risk capital can be questioned, especially in Europe, we can here speak of an investment gap, sometimes referred to as 'Death Valley'. Institutions like NRDC in the UK and Risiko Kapitaal in the Netherlands see it as their role to bridge this gap, but often suggest that too few 'suitable' projects show up. In this respect it is interesting to note that a new British subsidiary of Texas Instruments had acted as financier to ten small microelectronics firms that were not able to attract capital from their local banks (*Economist*, 5 July 1980). It is clear that what the financier regards as a 'suitable' project is rather different from the technological entrepreneurs' definition. The former is interested in collateral and in 'playing safe'; the latter is interested in new, and often long-term, techno-commercial potentialities.

In the US the availability of 'venture capital' also proved to be a sensitive determining factor in the foundation of new innovative firms. When this source of finance largely dried up in the early 1970s because of an increase in capital gains tax and more severe legislation with respect to risk-taking by retirement-fund managers, this was accompanied by a sharp decline in the number of new innovative firms. After changes in legislation in 1977, recovery took place almost immediately. Also in the US the provision of risk capital is rather location-bound, and also sector-bound, and less active than is usually suggested. Only a few of the 250 US venture capital funds invest in *new* firms.

As quoted from *Business Week* of 3 March 1980, 'Typically, venture pools have tended to operate more like risk-shy investment companies, funnelling most of the industry's $3 billion to $4 billion of capital into financing established companies and known technologies. Nowhere has this been truer than in the bank-related venture funds.' There are in the US a relatively few, specialized financiers who bridge the gap; these often have experience as technological innovators in their own right.

The functioning of a system of availability of risk capital is a complex matter, in which fiscal, cultural, financial, technical and local factors play a role. For example, in the US risk capital plays a major role in both Boston and San Francisco, but less so in Philadelphia and Chicago. Arthur D. Little (1977) reported that in the UK there is no lack of suppliers of risk capital, but that by the non-functioning of the stock market for issues by new firms, the overall system does not adequately function. The absence of an 'over the counter' stock market is also a hampering factor in the German Federal Republic and in the Netherlands.

The fiscal system

Taxation of private wealth can have a direct influence on the availability of risk capital. High income tax rates can be considered discouragements to invest in new high-risk firms with potentially very high profit rates. Further, the taxation of profits that are kept in the firm should be carefully treated since new innovative firms often have to finance their growth by those funds. For new firms the possibility for 'loss-carry-forward' is of importance. The above position illustrates the influence that the tax system can have on the environment of the entrepreneur, and the care that should be taken to adjust the fiscal system to the objectives of stimulating the start-up of new innovative firms.

Arthur D. Little (1977) have remarked that, contrary to the situation in the US, in the UK and in the German Federal Republic only a very small fraction of government R & D funds are available to new firms. In Europe generally, the preference seems to lie in achieving the national objectives of technology policy through large institutions and large firms, both natural partners of big government. In the US a National Science Foundation programme, ASRA, has been developed whereby research subsidies are made to new firms such that the awards are dependent on early commercial interest in the eventual results of the research. Furthermore, the Small Business Agency guards well the interests of the small firm (see chapter 9). In England the National Research and Development Corporation was established in 1949 with the explicit objective of commercializing inventions realized in government research establishments. In many countries similar organizations were founded, like ANVAR in France and SKE in the Netherlands (see chapter 9). These European initiatives have all had only a very limited impact on new technology-based start-ups.

Access to technical knowledge

Having, as its prime function, the creation and dissemination of technical knowledge – as well as being a potential source of new technical entrepreneurs – the national R & D infrastructure has, potentially, an important role in giving technical assistance to new firms who obviously do not possess the R & D potential of their larger counterparts. Given the different cultures between new firms and the R & D infrastructure, it is obvious that institutional hindrances remain substantial.

Clarke (1972) has discussed the influence of the scientific and technological infrastructure, and especially the influence of geographical variations in infrastructural scientific and technological endowment, on the regional incidence of technology-based firms:

> Thus, to the extent that a region is disproportionately under-represented in terms of a scientific infrastructure and to the extent that distance between the scientific infrastructure and industry has a deleterious impact upon the use of this technology source, then firms in that region will be at a competitive disadvantage compared with firms in regions not so under-represented. In general we should expect smaller firms to suffer a worse disadvantage because of their relative inability to support internal R & D capacities.
>
> In a region with this characteristic there would be two immediate results, other things being equal:
>
> 1. Firms would experience higher costs than those in other regions.
> 2. New small firms would be discouraged from moving into the region.

Clarke found, in the UK, a marked regional 'clustering' of centres of scientific and technological excellence which was, to some extent, reflected in patterns of establishment of new technology-based firms. A similar pattern was found by Müller and Nejedly (1971) in Czechoslovakia. Finally, Shimshoni (1966) also found strong evidence of this phenomenon in the United States. Moreover, Shimshoni further suggested that large public laboratories, as well as those of large firms, acted as 'incubators', spinning off numbers of technological entrepreneurs, to which the laboratories acted as a first market.

The patent system

It is a fact that many innovative firms are not based on patented inventions and, even when this is the case, the technical knowledge of the entrepreneur is of greater value than the patent. Success of a subject firm, in fact, is dependent on the rapid production of second and third generations of products. Patents can function both negatively and positively, being negative when the rights of the mother organization hinder a spin-off, and positive when the patent potential of a product makes obtaining risk capital possible. In general it can be stated that technological entrepreneurs lack the knowledge to profit from the patent system.

The market

Developments on the market are of prime importance for new innovative firms. The success of the American spin-off firms both on Route 128 and in Silicon Valley can be attributed to a large extent to government procurement programmes for aerospace and defence. An important institutional factor here was the preparedness to accept new, and not well-founded, firms as suppliers. In Europe there is an important cultural barrier against providing opportunities to new firms by governments, as well as a similar prejudice on the part of large firms.

In their early years new firms are often largely dependent on a single client. Several studies show, however, that after some four years a substantial percentage of turnover (about 40 per cent) is often achieved in other markets. This latter point can be considered of prime importance, since it would attach great value to the participation of new firms in government procurement programmes.

We cannot but close this chapter by a quotation from A. Shapero, William H. Davis Professor of the American Free Enterprise System at Ohio State University:

> To create capability for continuing economic self-renewal in the nation and its communities, economic development policies and programmes must abandon their emphasis on attracting large, established firms. Instead, they must focus on creating an atmosphere conducive to a high level of new company formations in a wide range of industrial sectors. Such a diverse base of new and small firms will make a community resilient, enhancing its capacity to adapt to economic dislocations and technological change and even to capitalize on new opportunities. (Shapero, 1971.)

We believe that it is possible to create an 'innovative infrastructure' which is conducive to new technological entrepreneurship and the generation of many vigorous, dynamic new technology-based small firms. This is, however, no easy undertaking, requiring changes in the attitudes of government, local authorities, bankers and even large firms. It is necessary to create a favourable 'culture', along with the supply of risk capital, technical assistance and enlightened, innovative market pull. These are all necessary if technological entrepreneurship on an appreciable scale is to occur.

Finally, it must be admitted that technological entrepreneurship is an intensely personal and idiosyncratic act, and while it might be doubted whether governments and other agencies can 'create' entrepreneurs, it is certain that they can act to create a climate in which entrepreneurship can flourish. It is equally certain that they can remove many of the barriers to entrepreneurship currently existing, especially in Europe. To change a national or local culture is, of course, a much more difficult and longer-term undertaking.

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6 NEW VENTURES AND LARGE FIRMS: THE SEARCH FOR INTERNAL ENTREPRENEURSHIP

Introduction

The popular view of the entrepreneur consists of an independent, courageous, enthusiastic and tenacious individual who seizes an idea or invention and who somehow establishes a new enterprise in order to exploit that idea commercially (Smiles, 1884; Roberts and Wainer, 1971; McCelland, 1971). However, while this 'classical entrepreneur' continues to play an important role as an initiator of innovations and founder of new business enterprises, the emergence of the large corporation, along with an increasing degree of concentration of industry, and particularly of the science intensive industries, requires the recognition and encouragement of a second type of entrepreneur, namely the 'intracorporate entrepreneur' (Rothwell, 1975a). As a company grows through exploiting its initial innovation, its management requirements change from something that is normally an idiosyncratic management style which is innovative, fluid and willing to accept high-risk developments, to one of stable management which has high administrative skills and is capable of ensuring the efficient running of the increasingly more complex organisation. Administrators, in general, tend to take a jaundiced view of risk-taking and innovation: they are often bureaucrats who tend to wish to maintain the *status quo* and to do things always 'according to the book'. The environment created, therefore, in the larger organization will often militate against innovation (particularly radical innovation) as well as against individual entrepreneurship occuring within that organization.

The measures increasingly being taken in a number of countries to stimulate new entrepreneurship and to facilitate increased rates of innovation in small firms indicate a recognition both of the problems of large firm entrepreneurship outlined above, and of the contribution small entrepreneural firms can make to high rates of industrial innovation and the growth of new technology-based industries. The Innovation Centres experiment in the US (and latterly in Canada and the Republic of Ireland) represents, perhaps, the most explict attempt to create greater numbers of independent entrepreneurs.

But given the current structure of industry in the advanced market economies, with the preponderance of large firms, any lack of innovativeness cannot be solved solely through the creation of more entrepreneurial small firms. It would therefore seem to be of crucial importance to seek structures for the stimulation of entrepreneurship in existing large corporations. Indeed, one of the major problems for the 1980s will be that of the ability, or otherwise, of major corporations to cope with structural change and to seek regeneration through radical innovation. Considerable evidence exists to suggest that intracorporate entrepreneurs can, and in fact do, exist in large corporations, and that they play an exceptionally important role in generating successful innovations. Some of the more convincing of this evidence is presented below.

A pioneer in this field, Schon, in his paper 'Champions for Radical New Invention' (1963), suggested that the answer to the problem of overcoming the characteristic reaction of large organizations against upsetting change and innovation lies in the encouragement of 'champions' for new ideas. The champion

> must be a man willing to put himself on the line for an idea of doubtful success. He is willing to fail but he is capable of using any and every means of informal ways and pressure to succeed. No ordinary involvement with a new idea provides the energy required to cope with the indifference and resistance that major technical change requires. It is characteristic of champions of new developments that they identify with the idea as their own, and with its promotion as a cause, to a degree that goes far beyond the requirements of their job.

Schon extended this concept to define the 'production champion' who operates within the large corporation. This is an individual with considerable power and prestige in the organization, who knows how to use the company's informal system of relationships, and whose interests extend not only to the new technology embodied in the product which he is championing, but include also the marketing, production and financial aspects essential to the product's development.

More recently in the US Globe, Levy and Schwartz (1973) made a comprehensive study of ten major innovations in an attempt to determine what factors played key roles in the complex series of activities that resulted in the innovations' outstanding success. They identified twenty-one major factors which made a significant contribution to the successful conclusion of the innovations. One of these factors, which they ranked sixth in their analysis of the frequency of occurrence of the various decisive events during the innovative sequence, was the Technical Entrepreneur.

He was defined as 'an individual within the performing organization who champions a scientific or technical activity; he is sometimes also called a "product champion".' In generalizing from the case histories, Globe *et al.* stated that

> the Technical Entrepreneur, whose importance was highlighted in the study of the 'factors', is also a 'characteristic' important in nine of the ten innovations. This is the strongest conclusion that emerges from the study. In fact, in three innovations, the technical entrepreneur persisted in the face of the inhibiting effect of an unfavourable market analysis. If any suggestion were to be made as to what should be done to promote innovation, it would be to find – if one can! – technical entrepreneurs.

Further evidence was provided in the results of Langrish *et al.*'s study in the UK of eighty-four innovations which resulted in the Queen's Award to Industry in 1966/67. Langrish *et al.* (1972) isolated seven specific factors of importance in the firm's success: two of these factors related to the presence within the firm of outstanding individuals. The first of these is an outstanding person in a position of authority who makes a special contribution to the innovation (e.g. Manager, Managing Director, Technical Director or Chairman). The second type of outstanding individual is one who, for instance, is described by his colleagues as a 'mechanical genious', and who possesses some unique form of knowledge that would otherwise not have been at the disposal of the firm. The factors 'Top Person' and 'Other Person' occurred numerically more frequently than any others in explaining success, and the latter individual was particularly important in innovations which embodied large technological change.

Perhaps the most detailed study of innovation which explicitly included consideration of the role of intracorporate entrepreneurs was project SAPPHO. In its final version, SAPPHO included the comparative analysis of twenty-two successful and twenty-two unsuccessful innovations in the chemical process industry, and twenty-one successful and twenty-one unsuccessful innovations in the scientific instruments industry (Rothwell *et al.*, 1974). This study underlined the crucial importance of the 'business innovator'; the individual who was actually responsible within the management structure for the overall progress of the project.

While the business innovator was important to success in both industries, his characteristics varied between the two. In scientific instruments, where most of the innovating firms were small, the successful business innovator approximated to the classical entrepreneur and his most important characteristics were commitment to, enthusiasm for, and involvement in, the project. In chemicals, while these characteristics were important, the further characteristics of authority and power were vital. In other words, enthusiasm and commitment were simply not sufficient to ensure success, and in order to alter significantly the course of the project, the business innovator in the chemical industry, which is characterized by very large, hierarchical and often bureaucratic firms, needs to be powerful enough to shape the project himself.

The need to promote entrepreneurship within the large organization in order to stimulate innovation and maintain growth has been recognized for some time, notably in the US, where a survey conducted in the 1970s suggested that one in four of the thousand largest American corporations in 1971 has established formal or informal intracorporate entrepreneurship programmes designed to facilitate entrepreneurial activity: this is the so-called 'ventures approach'. A useful formal definition was given by Cook (1971), which is: 'Venture management is the formalization of a new corporate-level activity designed to generate new business for the large organization primarily through the use of internal resources.' Venture management, it seems, is seen as a viable alternative to acquisitions as a means of entering new business areas; it allows firms to exploit technologies which do not altogether fit into existing operations and, perhaps most importantly, it combines the flexibility and entrepreneurial abilities of the small company with the considerable advantages of size.

In this chapter we will offer a general description of the new venture operation as an added weapon in management's armoury of strategies towards innovation and growth. We do not seek to present the new venture technique as a magical formula for instant innovative success, but rather simply as another approach towards achieving technical change and economic progress within the large company, and also as an alternative to the establishment of a new independent small firm as a suitable vehicle for individual commitment and entrepreneurial endeavour. We start with a description of a number of new venture approaches that are currently being practised in the US. Also the features of a variety of approaches utilized by a single large American corporation to stimulate in-house entrepreneurial activity are outlined. We shall then describe the process of successful industrial innovation, discuss the critical roles which need to be played by individuals within the business organization in order to achieve innovative success, and define different 'classes' of innovation according to their degree and type of novelty. The various new venture approaches will then be linked to both the innovation types which they are best suited to exploit, and to the critical roles necessary for them to encompass in order to achieve success. In this way this chapter aims at an integrated approach to the problem of innovating via the new venture method. Finally, some of the problems associated with the management of new internal venture operations will be discussed.

New venture approaches*

A spectrum of new venture approaches are currently being pursued by industry, primarily in the US. Some of these are described briefly below.

(a) *Retaining and stimulating entrepreneurs*

Here the object is to maintain the organization in its present form and to attempt to encourage entrepreneurs within this framework. However, the problems of bureaucracy, interference, lack of individual freedom, etc. will generally continue to exist, and resource allocation still tends to be biased against radical new innovation.

(b) *Venture capital operation*

The firm funds new ventures in new fields outside its traditional areas of interest. This is the simplest approach to administer since it requires only a commitment of cash. The new idea being exploited, and the entrepreneurs involved, might both have originated in the firm's own R & D laboratory.

(c) *Venture nurturing*

The firm provides not only cash, but also marketing, production, distribution and R & D assistance to the new venture. Here there is a fairly high level of corporate involvement and problems of autonomy and interference might occur.

(d) *Venture packaging and sponsored spin-off*

This involves the exploitation of ideas which have arisen in the R & D laboratory but which are not suitable, or irrelevant, for exploitation by the firm internally. Here a separate small firm is set up by enthusiastic employees to exploit the idea. The corporation supplies only some of the capital: the entrepreneurs and other outside interests provide the remainder. Hence the risk is shared.

* The authors' description of the various new venture techniques owes much to a presentation given by Prof. E. Roberts (Sloan School of Management, MIT) at Queen's University, Ontario, November, 1973, entitled 'Achieving Successful Industrial Innovations'. This section is taken largely from R. Rothwell (1975b).

(e) *Joint inside-outside ventures*

This tends to be a large firm/small firm tie-up. The large firm provides the cash resources and, if appropriate, access to production facilities and to channels of distribution. The small firm provides high technology, or specialized knowledge, and aggressive entrepreneurship. Some large firm/small firm US joint ventures are listed in Figure 6.1.

(f) *Internal venture operation*

This comprises the setting-up of a new venture operation completely within the existing organization to exploit the invention. It involves setting up a new division or a new product group within a division.

Large company	*Small company*	*Area of joint venture*
American Broadcasting Company	Technical Operations, Inc.	Black and white film transmitted to colour viewing over TV
American District Telegraph	Solid State Technology	Industrial security systems
Bell & Howell	Microx	Microfilm reader
Bravo Corporation	Anti-Pollution Systems, Inc.	Molten salt pollution control systems
Elliot Machine Div. of Carrier Corporation	Mechanical Technology, Inc.	High speed centrifugal compressors
Exxon Nuclear Corp.	Avco-Everett Research Laboratory	High-energy laser uranium isotope separation and enrichment
Ford Motor Company	Thermoelectron Corp.	Steam engines for automobiles
General Electric Co.	Bolt Beranek & Newman Inc.	Hospital computer system
Johnson & Johnson Co.	Damon Corporation	Automated clinical laboratory system
Mobil Corporation	Tyco Laboratories Inc.	Long-crystal silicon solar conversion technology
Pitney-Bowes Co.	Alpex Computer Corp.	Electronic 'point of sale' check-out systems
Roche Electronics Division of Hoffman-La Roche	Avco-Everett Research Laboratory	Inflation balloon heart assist system
Wyeth Laboratories, Division of American Home Products	Survival Technology, Inc.	Self-administered heart attack drug and injection system

Fig. 6.1 Some large-small US joint ventures. *Source*: Prof. E. Roberts, Sloan School of Management, MIT.

Although initially probably having a leaning towards R & D, it will be staffed by a multi-disciplinary team containing strong elements from marketing and sales. It should be awarded a separate budget. It should enjoy a high degree of autonomy in taking day-to-day operational decisions, and should proceed with a minimum of corporative interference. It will be able to draw on the corporate R & D, production and sales departments for help and advice. The atmosphere within the new venture group will be conducive to entrepreneurship, and its organization will therefore be flexible and non-hierarchical.

Whichever of the above venture modes the large organization adopts will, of course, depend on its corporate philosophy.* There is no reason, however, why the firm should not adopt a variety of modes, or a variety of approaches within a single mode. A spectrum of venture approaches adopted by a number of major corporations is shown in Figure 6.2. Below are outlined some features of the facilities and encouragement offered to entrepreneurial individuals to facilitate new *internal* venturing in a large and highly successful North American Corporation.

Venture capital	*Inside–outside ventures*	*Composite ventures*	*Internal ventures*
Dow Chemical Company	Ford, Mobil, G.E. Johnson & Johnson	Exxon	3M Company, British Oxygen Company (now discontinued)

——————► Increasing corporate commitment.

Fig. 6.2 Venture approaches adapted by a number of major corporations.
Source: Prof. E. Roberts, MIT.

(a) *Top-down entrepreneurial encouragement*

Presidents and other exalted executives who have made their way to the top through successful entrepreneurship in turn actively encourage this. It is a case of 'follow my example' rather than 'do as I tell you'.

(b) *Multiple internal sponsors*

There are three possible sources of monetary support and sponsorship for the exploitation of new ideas. The first is the entrepreneur's own department: it is legitimate for this department to diversify into new areas. The second is the central research organization, which is empowered to sponsor new ventures. The third is the organization's new business department. The firm provides for, and indeed, facilitates, personal mobility.

* It will also depend on the firm's current range of products and its in-house technological capabilities.

(c) *Early formation of 'product teams'*

New product teams are formed very early in the venture. They contain representatives of technical, production, finance and marketing. The team members take a risk in that if the new venture is a failure, they return to their original departments, generally losing several years seniority in the process: therefore they must be enthusiastic to join the team in the first place. The new development then becomes 'our' new idea, rather than simply 'a' new idea.

(d) *Full life cycle commitment to team*

As long as a new product team meets certain performance criteria (e.g. satisfactory technical progress, satisfactory sales), then the firm maintains a continuing commitment to the team. If the team fails to meet these criteria, then the firm's support is withdrawn.

(e) *No 'minimum size' constraint*

A new product development is not discontinued because it does not have a very large potential market. Provided that the expected or actual return on investment is deemed sufficiently large, then the project will proceed.

Finally, this company actively encourages internal competition between divisions, and it ties executives' incentives systems to what it calls 'building new businesses'.

Any organization will, of course, be limited in its choice of new venture approaches by its available resources. For example it is difficult to imagine a small or medium-sized firm attempting to adopt approaches (b), (c) or (d). Indeed, Susbauer (1973) found, from his survey of a large number of companies in the US employing intracorporate entrepreneurship practices, that 'smaller companies (less than $50 million in annual sales) reported less (intracorporate entrepreneurship) programme development than larger companies.' Further, 'larger companies have a clear tendency to establish formal programmes, while smaller companies are more likely to have established informal programmes or both kinds of programmes, if they have them at all.'* It is also interesting to note that 'companies which had initiated only formal programmes felt more positive towards their

* Susbauer defined *formal* intracorporate entrepreneurship programmes as (1) separate division of the parent organization, (2) a separate department of a division, (3) a separate subsidiary of the parent. *Informal* systems were: (1) part of a corporate department whose purpose is to seek new investment opportunities, *one* of which may be from ideas generated internally outside of normal R & D channels, (2) a department of the R & D activity, (3) new product committee, (4) employee suggestion reward schemes which sometimes result in entrepreneurial activity.

programmes (87 per cent) than companies which had initiated informal programmes, regardless of the size of the company, and a greater percentage of larger companies felt that their efforts were successful than smaller companies (82 per cent to 63 per cent).' This probably reflects the fact that the establishment of a formal programme represents a greater explicit corporate commitment to the new venture concept right from the start.

The successful innovation process

The transformation of a new idea or technological invention into a marketable product or process requires the existence of some sort of organizational framework within which this transformation might take place. The process by which the idea passes from inception to the market place is called the *innovation process*, and the business organization (in this case the new venture operation) can be thought of as a vehicle for sustaining this process and carrying it through to completion. (After all, the new business is founded, initially at least, to exploit a particular new idea, although at a later date it will be required to act as a foundation upon which further innovations, both radical and incremental, might be constructed.) This is a useful concept since we possess considerable knowledge concerning the industrial innovation process, and about the conditions that result in commercial success. If we can describe the process of successful industrial innovation and the characteristics of successful innovators, we should be able to describe the characteristics of the new business enterprise necessary to achieve this innovative success, and relate them to the different new venture approaches. A number of factors have been determined empirically which characterize the successful industrial innovation process (Rothwell, 1977):

(a) *Understanding users' needs*

Successful innovators have a very thorough and imaginative understanding of users' needs. They gain precise knowledge concerning the conditions in which the innovation will be required to operate. They interact, where possible, with potential customers throughout the course of the project and continually update their specifications in the light of changing user requirements. They take great pains to understand, and place priority on meeting, users' requirements rather than on satisfying their own egos!

(b) *Marketing and sales*

Between 70 and 80 per cent of successful technological innovations arise in response to the recognition of a need of one sort or another. Where the innovation arises as the result of new technology, the successful innovator determines that a need exists before he proceeds with the development, and he establishes that the need is sufficiently widely diffused (i.e. that the market is sufficiently large) for the innovation to be viable. The successful innovator mounts a comprehensive advertising and sales campaign and he educates users in the right uses and limitations of the innovation; he offers a comprehensive after-sales technical support service where appropriate. The successful innovator is aware of changing market conditions and requirements and of competitive developments elswhere.

(c) *Communications*

Successful innovators establish efficient internal and external communication networks: communications between the different functional departments within the organization are good, as are communications between the organization, the outside scientific and technological community and the market place. Successful innovations proceed in the light of perceived company strategy.

(d) *Key individuals*

Associated with successful innovations are various 'key' individuals ('product champions' or 'internal entrepreneurs'). They are enthusiastic towards the innovation, committed to it and involved with it. They afford the innovation their wholehearted support and 'push' it through to completion. Generally they require both technical and managerial expertise, which is embodied in a single, or several individuals.

(e) *Effective manufacturing procedures*

Successful innovations suffer fewer after-sales 'bugs' as a result of poor production procedures. They are designed and manufactured in a manner which is conducive to easy and speedy maintenance. Care is taken to ensure that materials used in construction are compatible with the environment in which the innovation is to function. Long term reliability is a prime factor in the original project specification.

(f) *Cash and manpower resources*

Successful innovations are allotted sufficient cash and manpower resources to enable technical problems to be solved effectively, prototypes to be built where necessary, and sufficiently large marketing and sales efforts to be mounted. At critical stages in the process, successful innovators focus resources into the innovation to facilitate its progress. Successful innovations are afforded full corporate backing right from the start.

(g) *Management style*

Successful innovations tend to arise in organizations that are flexible and capable of being adapted to facilitate the progress of the individual innovation. The management style is participative rather than centralized, consultative rather than authoritarian, and the organization is horizontal rather than vertical in structure. In short, 'organic' rather than 'mechanistic' organizations are conducive to the generation of successful innovations.

The successful innovation process just described does, of course, represent an ideal case and very few innovations, including successful ones, will perform equally well in all the seven areas listed above. Furthermore, innovation is an inherently risky process and this risk can never be completely eradicated. However, the results of project SAPPHO (Rothwell *et al.*, 1974) showed quite clearly that, on average, successful innovators out-performed failures in all the areas of competence associated with the process of innovation, and that success could rarely be explained in terms of a single factor only.

Critical functions

Having outlined the characteristics of successful innovators, and the successful innovation process, it is now possible to identify some of the *critical functions* which need to be fulfilled by individuals within the framework of the business organization in order to achieve this success (Roberts, 1977).

(i) *Creative scientist or inventor*

His primary role is to create new ideas. He is not necessary the right person to exploit them (frequently he is not, in fact, suited to exploit them!). His creativity must be channelled along paths dictated by corporate strategy and market needs rather than by personal whim.

(ii) *Entrepreneur*

His role is to champion the idea and to 'move it' through the organization. He seeks organizational support for the idea and convinces management of its worth. He is enthusiastic towards the idea and firmly convinced of its value and high market potential. He will generally be an aggressive, independently-minded individual.

(iii) *Project manager*

His role is that of administrator. He *integrates* the various differentiated functions and welds them into a continuous innovation process. (This might not be a designated individual; the function might be fulfilled by management generally.)

(iv) *Sponsor*

His role is to provide a window to the organization. He shows the entrepreneur 'the ropes'; how to obtain funds, where to seek support etc., which can be daunting tasks in the very large corporation. He will be an experienced (and perhaps not very active) senior member of the organization.

(v) *Technological gatekeeper*

He actually reads journals and he attends conferences. He provides vital technical information. He communicates outside of his immediate circle and interacts strongly with other groups within and outside of the organization. In short, he is an extremely effective transceiver of information (Allen, 1970).

(vi) *Production engineer*

He advises the R & D and design personnel on the limitations and possibilities of the production process; he advises on various preferred design procedures (e.g. use of standard modules) and the preferential use of certain materials. He oversees the manufacture of the innovation and irons out production bugs before commercial sales. He focuses attention on designing for 'makeability' (Rothewell, 1980).

(vii) *The marketeer*

He continually feeds in information concerning user needs and market changes. He specifies users' requirements. He maintains the group's awareness that the end-point of the operation is the market place. It is his input which very often initiates the search for the new innovation.

(viii) *Resource controller*

He allocates sufficient funds to the project to enable it to progress and ensures that technical, production and marketing manpower and raw material resources are available when required. He monitors costs and takes a hand in pricing procedures.

Each of these critical functions might be embodied in a separate individual, several of them may be embodied in a single individual, or several individuals may be employed in fulfilling a single function. However this might be, these functions must generally be fulfilled if the invention is to be transformed into a commercially successful new product or process. It is the function of the new business organization to provide a framework within which these various 'critical functions' might be encompassed and to integrate them into a united single operating entity.

Classification of innovation

Innovations come in a variety of shapes and sizes, and the type of organization, or the degree of organizational change, necessary to accommodate a particular innovation will depend on that innovation's degree and type of novelty. A classification of innovations is given below, along with the required organizational change to see each innovation type through to fruition (Collier, 1974).

	Scale of innovation	*Appropriate organizational change*
Type 1	Present product Present technology Present market	This is a product improvement and can be easily accommodated within the existing organization.
Type 2	New product Present technology Present market	Can again be developed within the existing organization with the formation of a new project team in the R & D department.
Type 3	Present product Present technology New market	Again, existing organization more or less maintained. Marketing must learn the idiosyncracies of new customers and perhaps a new sales team will be formed.
Type 4	New product Present technology New market	In this case, a new product group might be established, staffed primarily by R & D and marketing personnel. Manufacturing can still be done in company's existing department. Conventional firms might simply form new R & D project and sales teams.
Type 5	New product New technology Present market	Again a new product group might be established but staffed primarily by R & D and manufacturing personnel. Group may utilize the firm's existing marketing and sales department. Alternatively, a new

	Scale of innovation	*Appropriate organizational change*
Type 5 (cont.)		venture group might be established depending on the degree of novelty embodied in the 'new' technology.
Type 6	New product New technology New market	Represents a new business to the company. A completely new business organization (new venture company) might be established, or a new division formed within the existing organization.

It is quite clear from the above that a new venture operation is appropriate only when the project represents the generation of a new area of business for the firm.

The appropriate new venture approach

So far a spectrum of new venture approaches which are in current usage has been considered, the characteristics of the successful innovation process have been described, the critical functions associated with successful innovators have been listed, and a typology of innovations has been developed. It is now possible to bring these factors together and to associate the different new venture approaches with the particular innovation types they are best suited to exploit, and to the various critical functions which they must contain. This is achieved in Table 6.1 which will, it is hoped, serve as a guide in assisting management to choose the approach most appropriate to the particular task in hand.

The management of new internal ventures

The venture approach that demands the greatest corporate commitment, and which is perhaps the most difficult to pursue successfully, is the new internal venture. The establishment of a new and fairly autonomous work group within an existing organizational framework will create a number of problems of both a political and administrative nature, particularly when the company is employing this technique for the first time. It is necessary, therefore, when embarking on a new internal venture scheme, to approach it with much caution and to be armed with a great deal of forward planning and prepared alternative strategies. The composition of the new venture team, its leader, and its place within the existing company structure,

Table 6.1 New venture approach

	Retaining and stimulating entrepreneurs	Venture capital operation	Venture nurturing	Venture packaging and sponsored spin-off	Joint inside–outside ventures	Internal venture operation
Innovation type	a,b,c	f	d,e	f	e	d,e,f
Critical function						
(a) within new venture	–	i, ii iii, v vii	ii, iii	i, ii iii, v vi, vii	i, ii v	i, ii ii, v vii
(b) shared	–	viii	i, iv v, vi vii, viii	viii	iii, viii	iv, vi viii
(c) within parent	i to viii	iv	–	iv	v, vi vii	–

Table 6.1. Tabulates the six new venture approaches and shows for each approach:

1. the innovation types it is best suited to exploit:
   a. present product, present technology, present market
   b. new product, present technology, present market
   c. present product, present technology, new market
   d. new product, present technology, new market
   e. new product, new technology, present market
   f. new product, new technology, new market
2. the critical functions contained completely within it, the critical functions which are shared between it and the original company, and the critical functions which are retained by the original company:
   i – creative scientist or inventor
   ii – entrepreneur
   iii – project manager
   iv – sponsor
   v – technological gatekeeper
   vi – production engineer
   vii – the marketeer
   viii – resource controller

are all factors of extreme importance in determining the success or failure of the venture. Comments concerning these issues are given below.

The new venture team

The new venture team will, initially at least, in most instances be development-oriented. However, it must contain a balance of R & D, market, production and administrative skills. Team members may be part-time or full-time depending on the venture system chosen and on the availability of resources. There might be a combination of both part-time and full-time members with a small full-time core – or leader – and a varying number of part-time members from other divisions, brought in when necessary, and especially at critical phases in the development. Members should be enthusiastic and committed towards the venture. Their probable rewards for success and possible penalties for failure must be made clear at the outset. Where the firm is dealing in a completely new market area, marketing expertise should, when possible, be brought in from outside.

It is probable that there is a minimum threshold of resources below which the venture team will not be effective, although this will of course depend on the nature of the project. Jones and Wilemon (1972) examined the characteristics of venture teams in twenty-four large US corporations listed in 'Fortune 500'. The average size of these teams was about ten full-time members, with the number of part-time members varying from none to fifty. Clearly the full-time/part-time membership system affords a high level of flexibility and allows the firm to focus large resources on the project when necessary. Maintaining a relatively small core membership ensures that the enthusiasm for, and the commitment to, the project are not diluted.

The leader

The post requires a fine balance between youth and experience. Prior work will probably relate to the basic character and objective of the new venture team, which are to take a new technology or idea and to exploit it commercially. Probable backgrounds are R & D, engineering management, new product development, corporate planning. He will have a desire for independent action, but will be committed towards the organization and the innovation. He will possess the ability to work with and motivate people. He will probably adopt the 'confrontation' approach when resolving conflict within his team, or between them and the rest of the corporate body, rather than the 'smoothing' or 'forcing' approaches.* Jones and Wileman (1972) looked at the characteristics of the venture managers in

* See, for example, Rubenstein, Barch and Douds, 'Ways to Improve Communications between R & D Groups.' *Research Management*, Nov. 1971: '. . . the confrontation approach is one which involves an open exchange about the causes of intergroup conflict, and efforts are directed towards reaching a useful and mutually acceptable decision rather than forcing one side's solution or smoothing over the situation.'

their sample of twenty-four US corporations. They were generally in their early forties; 24 per cent held a technical degree, 32 per cent had a background in R & D, 16 per cent in engineering and 24 per cent in corporate planning. Von Hippel (1977), in his study of twelve new venture operations in the US, found similar characteristics for venture managers. He then goes on to make the important point, however, that 'We do not know whether these characteristics of venture managers differ from the characteristics of other classes of managers at the parent company. We do know that age level shows no differential correlation between success and failure.'

Finally Schrage (1965), in his study of R & D entrepreneurs, found that the successful person was high in achievement motivation and low in power motivation. This result was supported in the work on the motivation of fifty-three successful R & D entrepreneurs by Warner and Rubin (1969), who found the prime motivation was a high need for achievement which was much more significant than the need for power. These results, taken with the earlier discussion on the characteristics of successful product-champions/business-innovators, suggest that it is not power *per se* (or the search for power) that is important, but rather the power, or ability, to affect favourably the progress of his 'pet' project to achieve a successful outcome, that motivates the product-champion. The point is that the venture approach can provide the venture leader with this very opportunity, i.e. the power to guide the course of 'his' new venture.

Corporate support

The new venture operation must be given – and must be seen to be given – the support of top management. It helps if venture leaders are appointed by top management, which goes some way to ensuring the co-operation of others within the organization. When necessary, the support of the other operating divisions must be willingly given. The venture leader's level and range of authority must be precisely delineated at the outset. The role of the new venture group and its relationship within the organization must be spelt out clearly by top management, in order to help circumvent suspicion and unfounded jealousy on the part of other employees.

The corporation must also persist in its support. According to Roberts (1979), a corporation must be willing to commit itself to a minimum period of five years for just *beginning* to 'grow a new business'. This is seen to be one of the most important factors in the phenomenal success of the 3M Corporations' venture operations during the past thirty years. Further, except in the case of joint ventures with smaller firms, the large company might have to wait for up to ten years or more before it receives any significant income. This is clearly a problem during an era of high economic uncertainty and generally high inflation rates.

Autonomy

There is little sense in striving to create a new venture group which is designed to foster an atmosphere conducive to committed entrepreneurship and innovation, if management attempts to force it to conform with traditional operating procedures. The group must be confronted with the minimum of bureaucratic red-tape and interference, and be allowed the maximum degree of flexibility in its approach to the project in hand. However, it must be subject to independent assessment whereby its progress is monitored, and its aims checked against corporate and market requirements; it must not be allowed to persevere, and even 'grow like Topsy', simply by virtue of its own momentum. The team must, however, having been given clear and unambiguous objectives, be allowed as much operational autonomy as is practicable.

Discussion

There is, it seems, a growing awareness on the part of many large corporations – especially in the US – of the need to seek novel organizational forms in order to stimulate innovation and growth through internal entrepreneurship. As the new and science-intensive industries mature and become increasingly concentrated, the environment created in the large corporations which make up these industries can become less and less suited to individual commitment and entrepreneurial endeavour. As a result of this there has been a tendency for aggressively entrepreneurial and independently-minded individuals to leave the sometimes stifling atmosphere of the large company to establish their own small firms. A relatively new organizational concept, which is designed to combine the massive resources and varied skills of the large corporation, with the flexibility and personal involvement of the small firm, is the new venture group. There are a variety of new venture approaches currently being pursued in industry, particularly in the US,* and the appropriate organizational form chosen will depend on the company's corporate strategy, the level of its resources and on the nature of the innovation under development.

* For a description of the new venture approach as practised by a major UK company, see J. Gardner, 'Innovation through new ventures: new venture concept in BOC', *R & D Management*, vol. 2, no. 2, February 1973.

There is, as yet, little empirical evidence available concerning success rates among new venture operations, or of their levels of success in relation to other organizational forms utilized in parallel by firms during innovation; there are, indeed, reported some notable examples of failure.* Nevertheless, what limited evidence there is available suggests that, by and large, organizations employing the new venture approach feel that their attempts to create entrepreneurially vital activities in their companies are worthwhile.

Table 6.2 lists the reasons for the failure of twenty-one new venture approaches derived from interviews with top corporate management and with venture managers (Hlavacek, 1974). It can be seen that while the top corporate managers emphasized mainly financial problems, the venture managers placed greater emphasis on problems of internal conflicts. Further, while both groups emphasized the major problem of too small a potential market for the product, only the corporate managers mentioned technical problems. The general picture that emerges is one of caution and lack of long-term commitment by corporate management, and of internal friction and resistance to change experienced by venture managers in their dealings with other, more conventional, corporate departments.

The most popular form of venture management currently pursued in the US is joint small firm–large firm ventures (see Figure 6.1). Here the small firm generally supplies the dynamism, vigour, commitment and technology (i.e. supplies the entrepreneurship function), while the large firm supplies access to capital and to a comprehensive network of distribution, sales and after-sales servicing. Because of the very different behavioural characteristics of large and small firms, such a relationship can be fraught with problems. Two of the major problems, identified by Roberts (1979), are:

- small companies are prepared to, and indeed, often are forced to, take on-the-spot decisions, whereas large corporations often take months, if not years, to resolve their collective minds;
- small companies will shake hands on a deal, while large corporations employ a battery of lawyers to produce lengthy, and often complex, agreements.

Problems can also arise when the large firm, which is accustomed to selling often rather mature, standardized products, attempts to market highly innovative products using the same after-sales servicing network.

* For example, Du Pont's Corfam – see A. B. Robertson, *The Lessons of Failure*, MacDonald, 1974.

Table 6.2 Reasons given for the failure of 21 new internal ventures

TOP CORPORATE MANAGEMENT		VENTURE MANAGERS	
Reason for failure	Frequency*	Reason for failure	Frequency*
Sunk costs became too great	8	Market was too small	7
Market was too small	8	Distribution problems	6
Did not fit distribution system	8	Conflicts with divisional managers	6
Technical problems	6	Impatient top management	4
Wrong venture manager	6	Resistance from existing sales force	4
Drain on corporate-divisional profits	5	Marketing research inaccurate	4
Low return on investment	5	Budget too small	3
Conflicts with divisions	5	Inexperienced venture team	2
Termination of federal funds	2	Termination of federal funds	2
Weak lobbying effort	1	Decline in corporate profits	1
		Venture team too small	1

* In several cases, multiple responses were given.
Source: J. D. Hlavacek, 'Towards more successful Venture Management', *Journal of Marketing*, Vol. 38, No. 4, October 1974.

With radical new products there is a need to train customers in the right uses and limitations of the product, and to mount a speedy and efficient operation. Service personnel used to looking after standard products might experience difficulty in properly handling the new, high technology product, within existing structures and practice. Clearly, to handle the new product successfully requires some reorganization of the existing service network, which might meet with some resistance on the part of established corporate service management.

An alternative form of large firm–small firm relationship mentioned earlier is that of sponsored spin-off. General Electric, for example, established some ten years ago the Technical Ventures Operation. The main aim of TVO is to assist the commercialization of promising new product ideas which would otherwise not be exploited in-house, and it operates by bringing together the new technology, entrepreneurially-oriented individuals and capital; the capital derives both from GE and external sources of venture funds (Ben Daniel, 1973).

Finally, going back to the new internal venture, it is worthwhile repeating that this approach is not a magical formula for success via small firm-type entrepreneurship. Rather, it is one more weapon in corporate management's armoury of methods for achieving successful technological innovation. It does, however, appear to be particularly well suited to the stimulation of in-house entrepreneurship and to the exploitation of radical innovations that represent a new area of business for the large firm. It represents an explicit attempt to marry the 'human' advantages of the progressive small firm (dynamicism, flexibility, entrepreneurship) to the considerable advantages of scale enjoyed by the large corporation.

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7 SMEs AND EMPLOYMENT

(i) The unemployment crisis

Table 7.1 lists levels of unemployment in sixteen OECD member countries, averaged for the period 1962 to 1973, and separately for each of the seven years from 1974 to 1980. The table illustrates that since the oil crisis of 1974, unemployment increased significantly in most of the mature industrialized market economies and, with one or two exceptions, has since remained, by post-war standards, relatively high. Thus, the recovery of the world economy from the 1974–5 recession did not lead to a rapid fall in unemployment as had been the case with previous post-war recoveries (Rothwell and Zegveld, 1979).

A great many explanations have been forwarded for the continuing unemployment crisis, including the following, many of which are interrelated:

- reduced domestic real disposable incomes due to historically high and rapidly rising real energy (oil) costs;
- high rates of inflation, leading to a reduction in consumer purchasing power, and hence demand;
- a general reduction in investment due to decreased rates of profit, high interest rates and high labour-cost inflation;
- a shift in investment from expansion to rationalization, resulting in high job loss;
- a shift of labour in traditional areas to the low labour-cost LDCs, and a consequent increase in imports to the advanced industrialized nations, with heavy job loss in labour intensive areas (e.g. textiles, footware);
- anti-inflationary government policies which effectively reduce growth in demand;
- reduced rates of technological change with fewer opportunities for investment in radical new technologies to generate new markets, and regenerate existing ones.

It has been argued elsewhere that while the 1974 energy crisis, coupled to rapidly increasing rates of inflation, have both played their significant

Table 7.1 Levels of unemployment[a] (percentage of labour force)

	1962–73 (average)	1974	1975	1976	1977	1978[b]	1979[c]	1980[d]
Canada	5.3	5.4	7.1	7.2	8.1	8.4	7.4	7.4
United States	4.9	5.6	8.5	7.7	7.0	6.0	5.7	6.0
Japan	1.3	1.4	1.9	2.0	2.0	2.2	2.1	1.8
Australia	1.6	2.3	4.4	4.4	5.6	6.4	6.2	6.0
Belgium	2.1	2.6	4.5	5.8	6.6	7.1	–	–
Denmark	–	2.5	6.0	6.1	7.7	8.5	–	–
Finland	2.4	1.7	2.2	4.0	6.1	6.7	6.0	4.6
France	1.8	2.3	4.0	4.2	4.8	4.8	5.9	6.0
West Germany	1.3	2.7	4.8	4.7	4.6	4.3	3.2	2.8
Italy	3.6	2.9	3.3	3.7	7.2[c]	6.9	7.6	7.8
Netherlands	1.4	3.3	4.7	5.1	4.9	5.0	–	–
Norway	0.9	0.6	1.2	1.1	0.9	1.0	2.0	1.6
Spain	–	2.2	3.8	4.9	5.7	7.0	9.0	10.9
Sweden	2.1	2.0	1.6	1.6	1.8	2.2	2.1	1.8
United Kingdom	2.4	2.5	3.9	5.4	5.7	5.7	5.8	6.0
Ireland	–	7.9	12.2	12.3	11.9	11.8	–	–

Source: OECD *Economic Outlook* and *Selected Economic Indicators* – annual surveys for the years shown.
a National definitions, not adjusted for internal comparability
b 1978: latest three months available (usually second quarter)
c New survey definitions, not comparable with previous years
d First quarter
Taken from Rothwell and Zegveld (1981).

part in causing the current crisis in the world economy with accompanying high rates of unemployment, these simply accelerated a previously established trend; that the crisis is structural in nature and is related to fundamental changes that have taken place in the structure of industry and technology (Rothwell, 1981a and 1981b). This is closely related to the model of industrial evolution discussed in chapter 3. Thus, the 1970s approximates to the 'Maturity and Market Saturation Phase' described in Table 3.5.

In this respect, Figure 7.1 is interesting. It plots industrial output and employment in the EEC–9 between 1950 and 1980, with 1960 being indexed as 100 (Soete, 1981). It can be seen that between 1950 and about 1963/64, as industrial output increased, so did industrial employment. Between 1963/64 and 1971/72, while industrial output continued to increase significantly, industrial employment (with some marked fluctuations) remained, on average, at about the 1963 level. Between 1972 and 1980, while industrial output increased by about 30 points, industrial employment fell by approximately 8 points. Thus the mid to late 1960s

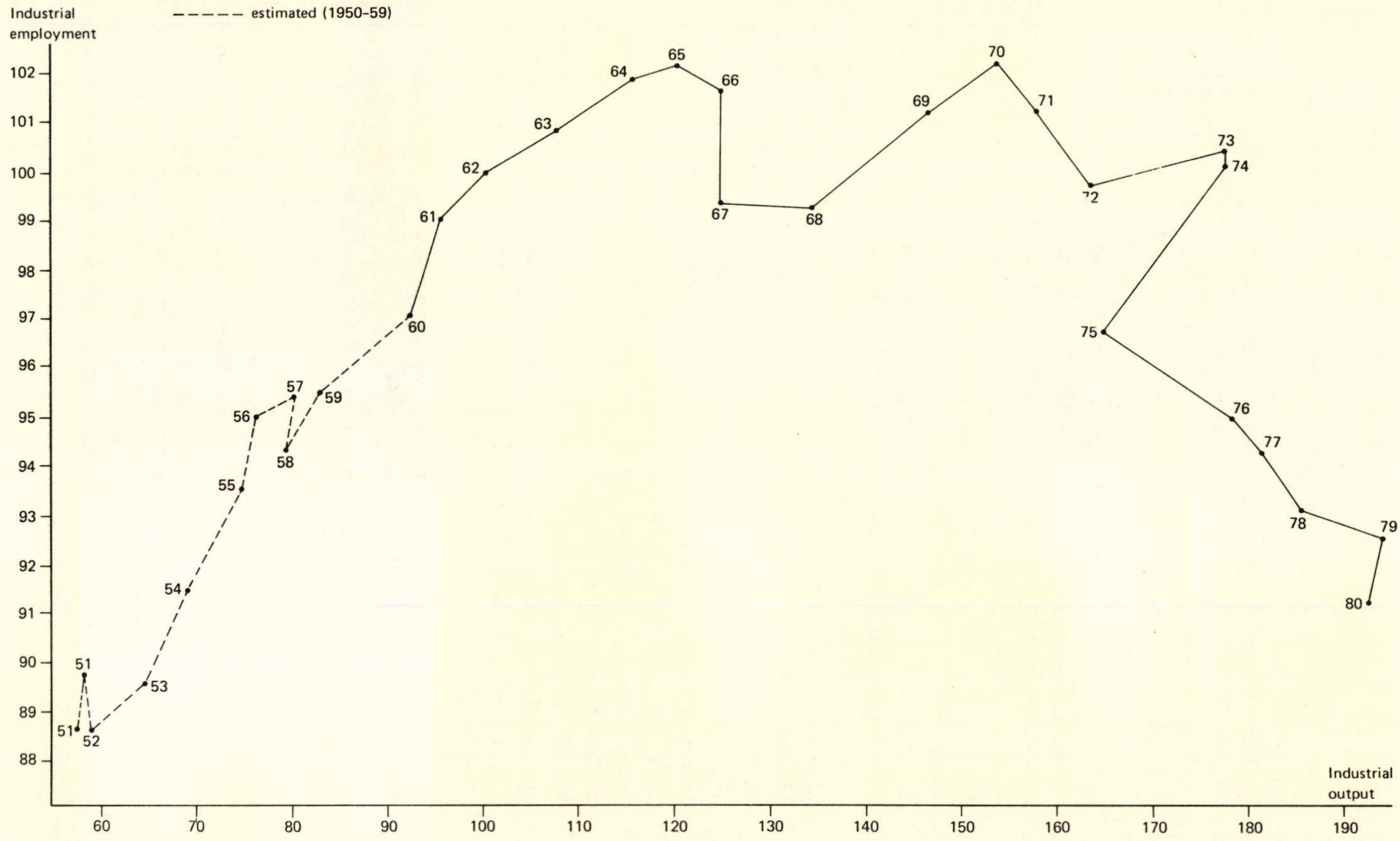


Fig. 7.1 Industrial output and employment in the EEC–9, 1950 to 1980 (1962 = 100). *Source*: Soete (1981).

was a period effectively of 'jobless growth', while the 1970s has been a period of 'deployment'.

From the early or mid 1960s onwards, there has been a fall in the share of non-residential construction in total investment within OECD, indicating a shift from expansion of capacity through the construction of new factories, to rationalization investment based on scrapping and replacement of equipment in existing plants.* Alongside this was an increase in concentration of industry and a fall in the number of small firms and their share of output throughout the 1960s. Moreover, rationalization on a significant scale in small firms is much more difficult than in larger firms because of the nature of production in small firms; they often manufacture 'one-offs' or, more usually, operate batch production in which automation and continuous flow are more difficult to achieve. (Some experts believe, however, that microprocessor devices offer greatly improved possibilities for flexible automated batch manufacturing in SMEs.)

Because of the apparently increasing tendency of large firms to rationalize their manufacturing operations, both by relocating the production of mature product lines in low labour-cost LDCs, and by investing in labour-saving technology, governments have increasingly voiced the belief that in the foreseeable future (and in the absence of any dramatic increase in world demand for manufactured goods) job generation on a significant scale will come about via the medium of new and fast-growing, and especially innovative, small firms. Certainly a recent and detailed analysis of government industrial innovation policy statements in a number of advanced market economies has shown a deep general interest in policies specifically to assist innovation in small firms, partly at least based on a belief in their ability to generate employment (Rothwell and Zegveld, 1981).

(ii) SMEs' share in national employment

Table 7.2 presents data showing the share of SMEs (or in some instances 'small firms') in national manufacturing employment in seven advanced market economies for a number of years during the 1960s and 1970s. Several things are apparent from these data. First, where time series data are presented, and with the exception of Japan, SMEs' share in employment

* Mensch *et al.* (1980), using data from 6,000 West German manufacturing companies, has shown that the ratio of expansionary to rationalization investment declined considerably (with some major fluctuating during 1967/69) from the early 1960s onwards. For example, while rationalization investment remained fairly constant between 1973 and 1975, expansionary investment fell by about 50 per cent.

Table 7.2 SMEs' share in manufacturing employment in seven advanced market economies

Canada	*In 1977, companies employing fewer than 200 people accounted for 43 per cent of employment in the manufacturing sector.*	
France	*SMEs' (< 500 employees) share in employment:*	
	1970 – 33.9 *per cent*	1976 – 32 *per cent*
Ireland	*Small firms (< 50 employees) share in employment:*	
	1963 – 22.6 *per cent*	1968 – 21.3 *per cent*
Israel	*Small firms (< 100 employees) share in employment:*	
	1974/75 – 40.2 *per cent*	
Japan	*SMEs' (< 300 employees) share in employment:*	
	1962 – 67.2 *per cent*	1974 – 69.2 *per cent*
Netherlands	*SMEs' (< 500 employees) share in employment:*	
	1974 – 59.7 *per cent*	
United Kingdom	*SMEs' (< 500 employees) share in employment:*	
	1972 – 32 *per cent*	1977 – 29 *per cent*
West Germany	*SMEs' (< 500 employees) share in employment:*	
	1961 – 54 *per cent*	1970 – 50 *per cent*

has declined over time. Second, it is clear that the role SMEs play in national employment varies a great deal from country to country, SMEs being particularly significant employers in the Netherlands, Japan, Israel, West Germany and Canada, and rather less so in the UK and France.

It is interesting that only in Japan, over the period covered, did SMEs' share in employment increase. This reflects the important role SMEs play in Japan as subcontractors to the large corporations, the latter feeling that this system can often allow them a great deal more flexibility than verticalization via expansion or take-overs. Thus, a healthy, vigorous SME sector in Japan reflects the remarkable success of the major Japanese corporations in world markets, in which SMEs share.

In a relatively small, young country like Israel, with comparatively few large, mature corporations, it is not, perhaps, surprising that small firms play a major role in national employment. In the UK where, as discussed earlier, small firms have traditionally been thought of as economically inefficient, and have attracted little government support, SMEs play the smallest role in national employment of all the countries covered in Table 7.2. Recent government policy statements in the UK, however, have emphasized the importance of SMEs to the national economy and to employment generation. As a result measures are currently being taken in the UK to facilitate the formation and growth of small firms.

Finally, in discussing the role of SMEs in employment, a dynamic approach is preferable, which might take into account openings, closures, expansions and contractions. Such an approach should, if possible, take into account the differences between the employment potential of existing SMEs and that of new small firms.

(iii) SMEs and job generation

The rather widespread belief in the employment generating potential of SMEs rests, as yet, upon a rather limited empirical foundation. Indeed, it seems probable that this employment potential will vary from sector to sector and between different nations.

Perhaps the greatest contribution to the debate on firm size and job generation is the work of Birch (1979) who examined employment change in 5.6 million business establishments (but rather fewer independent companies) in the manufacturing and private service sectors in the United States between 1969 and 1976. Adopting a dynamic approach, he looked at new openings plus expansions (equals gross new jobs) and closures plus contractions (equals gross job losses) from which he computed net job change. Birch's main conclusions were:

- gross job loss through contraction and closure was about 8 per cent per annum;
- of gross job gains, approximately 50 per cent derived from expansions of existing companies and about 50 per cent from new openings;
- of the 50 per cent of jobs created by new openings, half were produced by independent, free-standing entrepreneurs, and half by multiplant corporations.

Table 7.3 summarizes Birch's results regarding the contribution to *net* job generation by firms/establishments of different sizes. It shows that 66 per cent of net new jobs were created by firms/establishments employing less than twenty people, of which 51.8 per cent were created in independent firms. The most startling results are for the US manufacturing sector, in which firms/establishments employing fewer than 50 people showed large net job creation, while the larger firms, especially those in the largest size category, showed a substantial net job loss.

Storey (1980) has presented data comparing employment change by size of firm/establishment in both the United States and the United Kingdom over roughly comparable periods (Table 7.4). If the UK data, which are taken from the East Midlands, are at all representative of the country as a whole, then there is a remarkable similarity in terms of

Table 7.3 Percentages of net new jobs generated by size in the United States

Firm/establishment size	0–20	21–50	51–100	101–500	500+	Total
All	66.0	11.2	4.3	5.2	13.3	100
All independent firms	51.6	4.4	0.0	−1.5	3.1	57.8
Manufacturing	360.0	61.7	−27.3	−163.4	−336.7	−100

Source: Birch (1979).

manufacturing industry job generation by size between the United States and the United Kingdom.

As stated above, Birch's data suggest that between 1969 and 1976, approximately 50 per cent of gross new jobs in the US were generated by new firms, of which half (25 per cent of gross new jobs generated) were founded by 'free-standing' entrepreneurs. Using data from the East Midlands between 1968 and 1975, Storey (1980) found that of the approximately 55,600 total jobs created in openings, 23,200, or just under 42 per cent, were created through openings of wholly new manufacturing establishments. Storey did find, however, that the contribution of wholly new establishments to total job creation varied a great deal from one area of the country to the next (e.g. approximately 15 per cent in Clydeside, 20 per cent in Cleveland, 53.5 per cent in the West Midlands). Thus, new

Table 7.4 Manufacturing employment change by size in Britain (East Midlands) and United States, as a percentage of total manufacturing employment in base year

	Size					
	0–20	21–50	51–100	101–500	500+	Total
United States 1969–76	+3.2	+0.5	−0.2	−1.5	−2.9	−0.9
East Midlands 1968–75*	+2.7	+2.3	+1.5	−2.2	−5.9	−1.5

* Openings for East Midlands are placed in 1975 size band, but *in situ* plants and closures are according to 1968 size. The procedure is assumed to be identical to that adopted by Birch.

Data derived from: East Midlands: Fothergill and Gudgin (1979); United States Birch (1979).

Source: Storey (1980).

firms play a more significant role in total new job generation in the relatively more prosperous areas of the UK than in the assisted areas, and Storey estimates that for the UK as a whole not more than 15 per cent of gross new manufacturing jobs per decade are created by wholly new establishments. According to Storey, this should not be taken to suggest that *small* UK firms have performed badly in creating employment. On the contrary, he points out that 'the reverse is the case since it is *only* small firms which show an aggregate tendency to increase employment.'

Fothergill and Gudgin (1979) have presented detailed time series data on the cumulative employment contribution of new firms in the Leicestershire district of the UK. Their data are presented in Table 7.5.

Table 7.5 Employment in new firms in Leicestershire during the period 1947–79

	Cumulative employment in post-1947 new firms*	as a % of manufacturing employment
1947	0	0
1956	6,100	3.8
1968	14,800	8.8
1975	27,600	17.0
1979	36,000†	23.0

* Wholly independent firms set up for the first time.
† Estimated.
Source: Fothergill and Gudgin (1979).

Table 7.5 shows that firms founded since 1947 in the county of Leicestershire currently account for nearly a quarter of all manufacturing jobs in that county. Moreover, Fothergill and Gudgin found that these new firms, on aggregate, experienced substantial net growth even after their very early years. A further analysis, which looked at the rate of net new firm generation for three periods (1947–56; 1956–60; 1968–75) showed that, while the rate of new firm formation had remained more or less constant during the first two periods, it increased by about 30 per cent during the latter period.* In addition, the firms founded more recently have grown slightly more rapidly. Fothergill and Gudgin point out, however, that 'Despite the fact that new firm formation appears to be as

* The net job loss of 0.37 per cent of manufacturing employment in the county between 1968 and 1975 was borne by existing firms.

buoyant as ever, the important point is that new firms provide a substantial number of jobs only in the very long run.'

Fothergill and Gudgin then go on to look at the contribution to employment of the growth of existing firms, pointing out that 'Both in the short and long-term – though to a lesser extent in the latter – existing firms, rather than the formation of new ones, have been the main source of changes in employment levels.'

Using data for the East Midlands for the period 1968–75, and broken down by size and corporate status, they found the following patterns:

- Net growth declines with size, though the decline levels off for establishments with more than one hundred employees.
- Loss of employment in closures, and the net growth of survivors, both declined as size increases, i.e. the larger the plant, the less likely it is to close, but the more likely it becomes that it will show poor growth.
- Size is a more important influence on growth than corporate status.

Fothergill and Gudgin then make the important point that the superior growth of small enterprises may not be so much the result of their *size*, but rather a function of their *age*. In other words, many small firms are also very young firms. Testing this hypothesis on their post-war data set for the county of Leicestershire, they found the following:

- The net increase in employment in very small plants is entirely due to young firms and young branch plants. Older (pre-1947) small plant declined.
- Young firms, established during the previous twenty years, show much better growth than young branches of existing companies.
- There is still evidence that size affects growth, as growth declines with size among both young *and* old establishments.

Thus, from these data, we might conclude that, in the longer run at least, significant job generation might be achieved through the medium of many new, initially small independent firms. Elsewhere, however, Gudgin, Brunskill and Fothergill (1979) raise the important question of whether new small firms generate net new jobs, or whether they simply take jobs away from existing firms in an area, or from firms in other areas. In a novel attempt to provide an answer to this question, they asked their sample of forty-seven independent new firms in the East Midlands where they sold their products.

They found that 41 per cent out of the firms served markets mainly within the East Midlands and were therefore likely to displace jobs primarily within other local firms selling in the region. Forty per cent of the firms had their markets elsewhere in the UK and thus might be expected to displace jobs in other regions, but represent a net gain for the East Midlands. Nineteen per cent of the firms were exporters, and might represent a net gain in jobs for the UK as a whole. Moreover, since many of these were relatively young firms, they might be expected to grow and expand their geographical market base, and especially their exports.

Another important question here, and one which is of especial relevance to issues of regional development and employment generation, is that of ownership; specifically, we mean the issue of the acquisition of relatively successful and dynamic small firms by larger companies, and its influence on the performance of the acquired firms. Meeks (1977), for example, found from his analysis of more than 200 quoted company take-overs in the UK between 1964 and 1972, that in those cases where the acquirer was large in relation to the acquiree, the latter's profitability was large in relation to that of the former, being about 30 per cent above the industry average. Significantly, Meeks found a significant post-merger decline in profitability of the merged company, even where the acquiree was relatively small, and where the merger process would thus be expected to present fewer major organizational problems.

In the United States, Udell (1969) and Brue (1971) have shown that post-merger profitability decline is also often associated with either an absolute decline in employment or a decline in the rate of growth in employment. Smith (1979), from his study of take-overs between 1963 and 1973 of plants employing more than one hundred in the Northern Region of England (which accounted for 90 per cent of total employment in the region), found some indication that effects similar to those described by Udell and Brue were occurring in the UK. Smith's main conclusions can be summarized as follows:

- Compared to externally controlled branch plants, and the domestic (regionally controlled) sector, the externally acquired sector did exhibit a distinctive employment performance (after allowing for the effects of steel rationalization).
- This performance included a relatively high closure rate; a relatively low rate of new establishment formation; a relatively high rate of growth in surviving establishments due primarily, however, to the pre-merger period performance.
- A probable negative aggregate employment effect of about 20,000 jobs, which is approximately 80 per cent of the total loss of regional manufacturing employment between 1963 and 1973.

These results suggest that regional development and employment growth can best be served via indigenous firms. In particular, new small firms, preferably operating in fast growing markets for technology-based goods, would appear to be the most potent tool, at least in the longer term, for regional economic development and job creation.

Turning again to the general question of firm size and employment, a number of Canadian studies have indicated a superior employment generation by smaller firms over their larger counterparts. For example, the Ontario Manpower Secretariat, using data from a Statistics Canada Labour Force Survey,* showed that 59 per cent of total growth in commercial employment (manufacturing and services) between 1966 and 1978 derived from firms employing less than twenty people. As Orr (1980) states, 'Since small firms (i.e. less than twenty employees) currently represent only one-third of total commercial employment (in Canada) this means that the rate of job creation by the smaller firms over the twelve year period ending in 1978 grew 3.6 times faster than for the larger firms (i.e. the small firm growth rate was 6.5 per cent per annum, versus 1.8 per cent per annum for larger firms).'

A second Canadian study, commissioned by the Canadian Federation of Independent Business in 1979, showed that businesses (manufacturing and services) with twenty or less employees created 72 per cent of all new jobs in Canada between 1969 and 1977. In contrast, between 1961 and 1971, small firms accounted for only 26.8 per cent of new jobs.* Thus, during the 1970s, the relative contribution of small firms to job creation in Canada appears to have increased significantly.

In a more recent, and detailed, study Orr (1980), operating with Canadian census data, has looked at job generation by firm size in four sectors of Canadian industry: the retail trade, the wholesale trade, service trades and manufacturing. Between them, these four accounted for 60 per cent of all Canadian commercial employment in 1971.

Unfortunately Orr's data base did not enable him to distinguish between independent businesses and affiliated businesses (i.e. between firms and enterprises). At the smaller end of the size spectrum, he states that this is probably unimportant, since this is the region in which working proprietors predominate. He does not, however, define precisely what he means by 'the smaller end of the size spectrum'.

Figure 7.2 shows Orr's results for the manufacturing sector for the period 1966 to 1976, both in terms of net employment growth by firms in the different size bands, and percentage growth over the ten year period. It can be seen that the greatest net growth has been in SMEs (firms

* Results taken from J. Orr (1980).

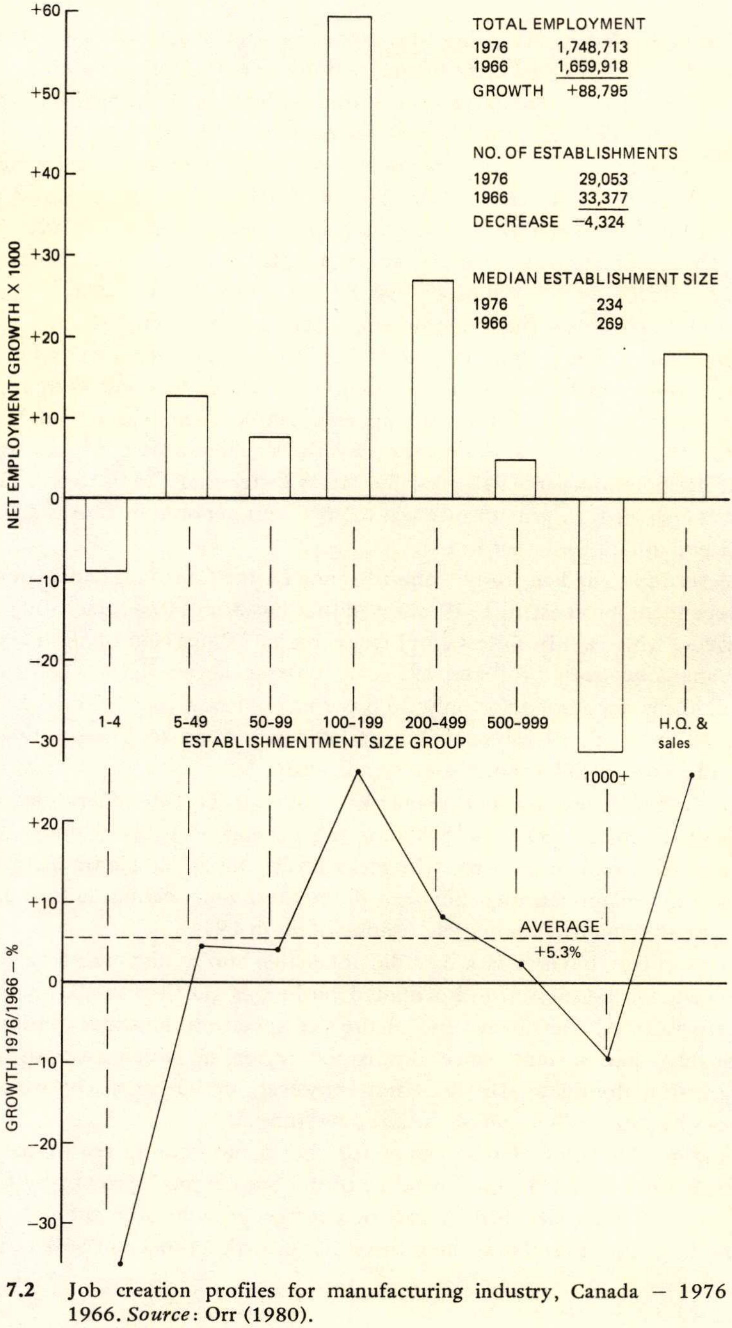


Fig. 7.2 Job creation profiles for manufacturing industry, Canada – 1976 vs. 1966. *Source*: Orr (1980).

employing less than 500) and that the most remarkable creation of new jobs has been in firms employing between 100 and 199 persons.

Orr's results can be summarized briefly as follows:

- The highest level of job creation, both in absolute as well as relative terms (25.8 per cent), occurred for the 100–199 size group.
- 61.5 per cent of increased employment occurred in establishments having less than 500 employees.
- In contrast, during the period 1961 to 1966, the group of size less than 500 employees contributed only 46.6 per cent in total employment increase.
- During the period 1966–71, in which total manufacturing employment decreased by 1.3 per cent, employment in the 100–199 size group increased by 10.2 per cent. During the same period, almost all the loss in employment occurred in the 'over 1,000' size group.

While the above results tend to support, at least from the point of view of employment generation, a vigorous small firm (or, more precisely, small establishment) sector in Canada, care is nevertheless required in interpreting them. Specifically, some of the changes in employment in the different size bands might reflect, at least in part, expansions or contractions from one band to the next, rather than expansions from within a particular band. Despite this, Orr's results are rather convincing evidence for the superior job generating potential of SMEs over their larger counterparts in Canada.

Finally, an interesting aspect of Orr's analysis is his discovery of a wide divergence in job generation between Canadian-controlled and foreign-controlled firms. This is a crucial issue for Canada where about half of manufacturing industry is foreign owned. Orr found, for the period 1970 to 1974, that Canadian-controlled firms created 4.6 times as many jobs as US-controlled subsidiaries, and that the relative growth of employment was 2.9 times greater for the Canadian-controlled firms. Presumably the portion of his sample represented by Canadian-controlled firms contains a greater percentage of independent firms than does the total sample, which further reinforces the role of small firms as generators of employment in Canada.

In summarizing the above sets of results it is probably true to say that the available evidence does support the contention that the current preoccupation by a number of governments with small firms, especially new small firms, as a vehicle for employment generation has some justification. It would, however, be unwise for governments to expect massive job generation via small firm creation and growth in the short to medium term. Nor must the contribution to existing employment of large firms be ignored. Rather a dual programme of new firm creation and the regeneration of existing large firms would appear most sensible.

(iv) New technology-based firms and job generation in the United States

As we saw earlier, following the 1974 oil crisis, unemployment increased in most of the advanced market economies and has since remained relatively high. In the United States, however, there has been some reduction in unemployment following the post-war 'high' of 8.5 per cent in 1975. Since the US labour force has increased fairly rapidly during the past five years, this does reflect some success in generating new jobs through active employment policies and expansionary economic policies.

As Fig. 7.3 shows, manufacturing employment in the US has increased since 1975 as industrial output increased, which is in contrast with the situation in most other advanced countries (see Fig. 7.1). The reason for this might lie, at least in part, in differences in the structure of US industry compared to the industries of Western Europe. Specifically, it might to some extent be due to the relatively high incidence of NTBF formation in the US.

The Arthur D. Little Report (1977) discussed in chapter 3 indicated that NTBFs have played a major role in the post-war US economy, while their role in the United Kingdom and West Germany has been only small. In the Silicon Valley area alone, for example, in 1974 there were about 800 NTBFs with annual sales totalling $2.5 billion. At the same time the number of NTBFs in the UK was only about 200 with total sales of £200 million, while in West Germany the number was even less. In the mid 1970s there were something like 2,000 NTBFs in the United States employing in excess of two million.

Although the regenerative capacity of SMEs in Europe might be higher than in the US, the majority of these probably operate in areas of medium to low technology, with a rather low propensity for significant growth. Certainly trade statistics suggest that US exports are more technology intensive than those from other major OECD exporters (Kelley 1978), although indications are that Japan is catching up fast. As we saw earlier, the United States led the world in the production of discreet semiconductors and semiconductor devices, and followed suit with the production of microelectronic circuits and devices. Moreover, in the case of discreet semiconductors at least, initially small, but fast growing, high technology firms played a major role in the development of that industry. It might be, therefore, that the more recent development of microelectronics

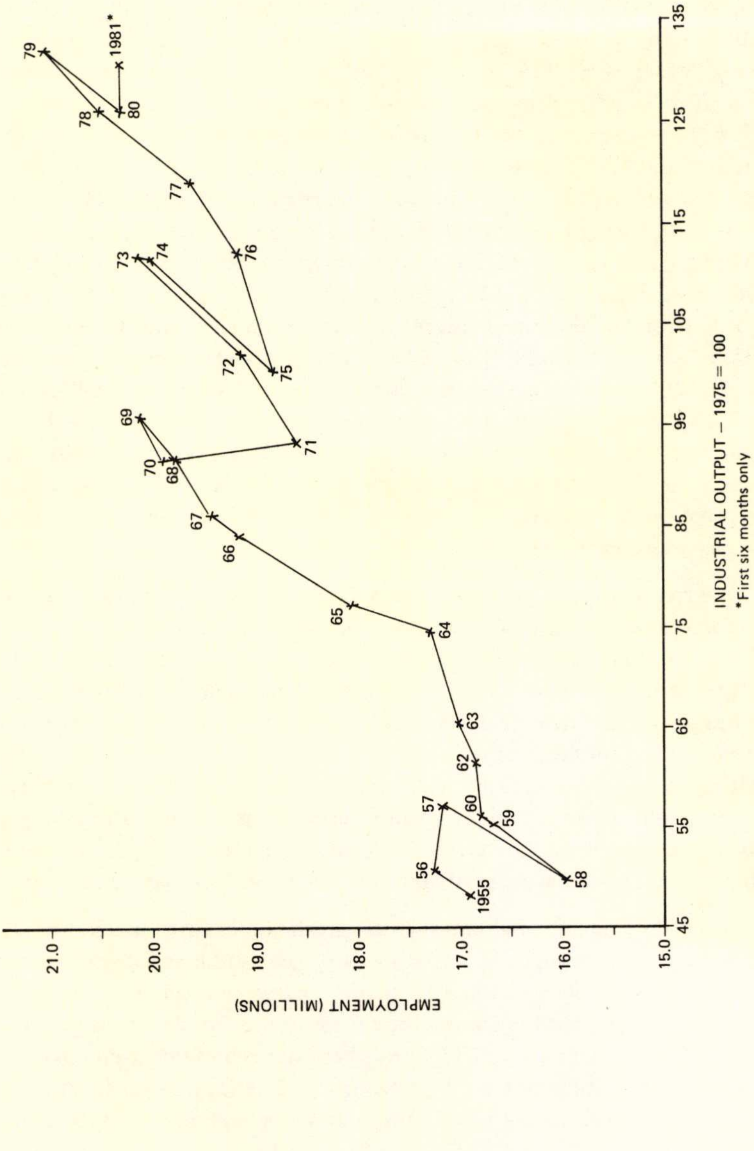


Fig. 7.3 United States: manufacturing output and employment, 1955–81.* *Source*: Luc Soete, Science Policy Research Unit.
* First six months only.

in the United States has played an important role – especially in the area of applications – in the creation of many new, fast growing, high technology firms (see Fig. 3.7). (Between 1963 and 1973, the growth of the US semiconductor industry was five times that of the US GNP; growth of the integrated circuit segment was about 80 times that of the US GNP.)

Now, while Birch (1979) highlighted the important role small firms have played in generating net new jobs in the US, he did not consider separately the specific case of NTBFs. A number of studies have been performed in the US, however (albeit not covering the post-1975 'oil crisis' period), which point to the superior job-generating potential of, in the first instance, young firms, many of which are high technology-based.

The first study, undertaken by the American Electronics Association (1978), was a survey of 325 AEA member companies. In 1976 these accounted for $45 billion in revenues, 14 per cent of total US exports, employed 750,000 people, paid $1.8 billion in federal corporate income tax and $700 million in state and local taxes, and spent $2.2 billion on R & D. Eighty-five per cent of the companies were founded after 1954.

The AEA study also looked at the job generating potential of firms in the sample of different ages. Their results are shown in Fig. 7.4, which gives the employment growth rate of firms in 1976 in different age bands. They can be summarized as follows:

- Firms ten to twenty years old had an employment growth rate twenty to forty times the rate of firms more than twenty years old.
- Firms between five and ten years old had an employment growth rate fifty-five times that of the mature (more than twenty years old) firms.
- Firms less than five years old had an employment growth rate on average 115 times that of the mature firms.
- Although the mature firms had twenty-seven times the total employment of the firms less than twenty years old as a group, the younger smaller firms created an average of eighty-nine new jobs per company in 1976, versus an average of sixty-nine new jobs per mature company.

Thus, even though the total employment in the older firms was by far the greatest, and even though they continued to generate new jobs, the most significant new job generation was in the smaller younger firms. Finally, it is worth pointing out here that all the firms in the sample were operating in areas of high technology. The study therefore represents a comparison of the job generating potential of 'young' technology-based firms with that of 'older' technology-based firms, and not technology-based firms versus 'others'.

A second US study (Morse, 1976) compared the rate of growth in

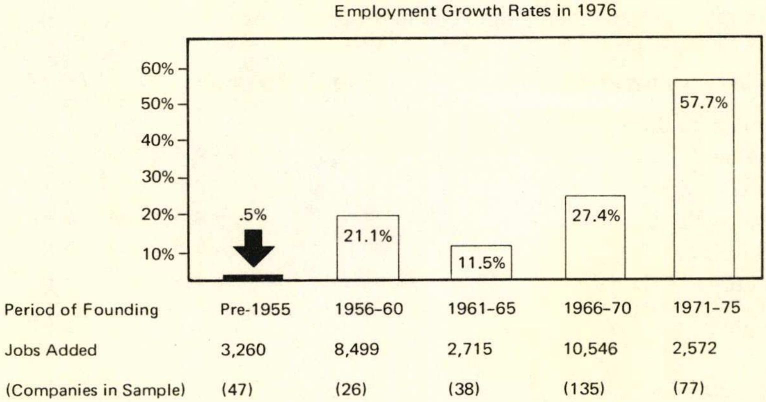


Fig. 7.4 Young companies create jobs much faster than mature companies.
Source: American Electronics Association (1978).

employment and sales of several 'categories' of firms in the US between 1945 and 1974. The three categories employed by Morse were 'mature' companies, 'innovative' companies and 'young high technology' companies. His results are set out in Tables 7.6 and 7.7, and show quite clearly the rather more spectacular growth rate in both sales and employment of the young high technology companies. For the five year period 1969–74, the average annual percentage growth rates, in sales and employment, for the three categories of firms was:

– Mature companies: 11.4 per cent sales; 1.6 per cent jobs.
– Innovative companies: 13.2 per cent sales; 4.3 per cent jobs.
– Young high technology companies: 42.5 per cent sales; 40.7 per cent jobs.

The study further showed that:

– Young technology companies with sales equalling only 2 per cent of those of the mature industry leaders created 34,369 new jobs, or 34 per cent more than 25,559 new jobs created by the mature companies.
– Total employment in the mature firms increased by only 3.2 per cent over the five years compared to 23.7 per cent for the innovative companies.
– The younger innovative companies with ending sales amounting to only 58 per cent of those of the mature companies created 106,598 new jobs, or over four times as many as the mature firms.

Table 7.6 Average annual growth (compounded), 1945 and 1974; mature companies and innovative companies

Mature companies	*Sales (%)*	*Jobs (%)*
Bethlehem Steel	4.9	−1.7
Du Pont	8.6	2.6
General Electric	8.4	3.5
General Foods	8.2	4.5
International Paper	9.2	2.8
Proctor and Gamble	9.6	3.8
Weighted Average	7.8	1.9
Innovative companies		
Polaroid	14.0	9.0
3M	14.1	9.0
IBM	16.8	10.2
Xerox	24.2	19.4
Texas Instruments (1953–74)	21.2	17.3
Weighted average	16.5	10.8

Source: Morse (1976).

Table 7.7 Average annual growth (compounded), 1969–74; young high technology companies

Date incorporated			
1968	Data General	140.5	82.5
1959	National Semiconductor	54.3	59.4
1960	Compugraphic	50.2	24.0
1957	Digital Equipment	36.8	30.7
1964	Marion Labs	24.5	25.4
Weighted average		42.5	40.7

Source: Morse (1976).

Finally, a study in 1977 by Data Resources, Inc. for the General Electric Corporation found, in comparing the performance of high technology firms with that of low technology firms in the United States between 1950 and 1974, the following (taken from NSF, 1979):

- Employment in high technology firms grew nine times as fast.
- Productivity grew at three times the rate.
- Output expanded twice as fast.
- Prices increased only one-sixth as rapidly.
- High technology firms produced a trade surplus of \$25 billion in 1974; low technology products declined from break-even to a \$16 billion deficit in 1974.

Thus the AEA study, and that by Morse, both provide strong evidence for the high job generating potential of young technology-based firms in the United States while the Data Resources study points to the superior performance of high technology firms generally. The fact that new technology-based firm formation appears to have increased in the US following a marked 'low' in 1974–75 (*Business Week*, June, 1980) might, at least in part, explain the relative success of US manufacturing industry in reducing levels of unemployment from the high level of 8.5 per cent in 1975.

(vi) Innovation and employment

As a final point in this chapter it is worth noting that evidence exists from several countries to suggest that, in general, 'innovativeness' in firms is associated with employment generation. Piatier (1981), for example, found from his study of innovation in French industry that innovation was associated with employment gains in 59 per cent of innovative firms, and in employment loss in only 5 per cent of innovative firms. For non-innovative firms operating in the same markets, the figures were 26 per cent and 14 per cent respectively.

In a detailed and comprehensive study of innovation in Canadian industry, De Melto *et al.* (1980) found that in the majority of cases innovations were associated with either no change, or with an increase in numbers of both production and non-production workers, although the positive relationship was strongest for product, rather than process, innovations; the introduction of product innovations led to increases in the number of production and non-production workers in 70 per cent and 60 per cent of cases respectively. Comparable figures for the process innovations were 43 per cent and 41 per cent respectively. Further, the introduction of 20 per cent of all process innovations resulted in a net decrease in the number of production workers in each case, while 37 per cent resulted in negligible changes in numbers of productions workers. De Melto *et al.*'s results are summarized in Tables 7.8 and 7.9. Significantly,

Table 7.8 Proportion of innovations resulting in net increase, net decrease or negligible change in the number of production and non-production workers, by type of innovation

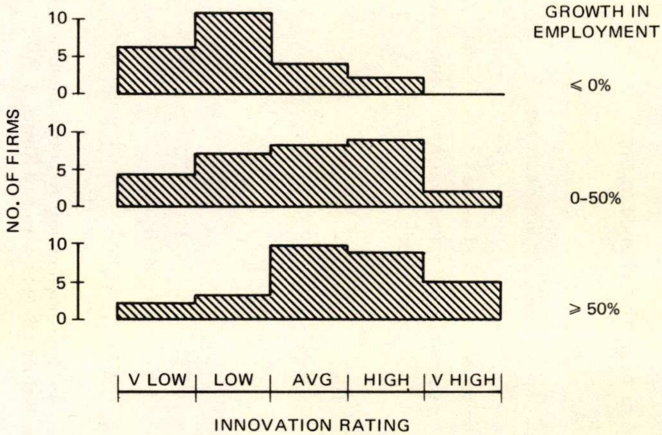
Type of innovation	Negligible change		Net increase		Net decrease	
	No. of innovations	% of innovations	No. of innovations	% of innovations	No. of innovations	% of innovations
Production workers:						
product	57	28	139	70	4	2
process	28	37	32	43	15	20
Non-production workers:						
product	71	37	117	52	1	1
process	41	58	29	41	1	1

Reproduced with permission from Economic Council of Canada Discussion Paper No. 176, 'Preliminary Report: innovation and technological change in five Canadian industries' (Ottawa, 1980), by Dennis P. De Melto, Kathryn E. McMullen and Russel M. Wills, Table 12, p. 161.

Table 7.9 Proportion of innovations resulting in net increase, net decrease or negligible change in the number of production and non-production workers, by firm size

Firm size	Negligible change		Net increase		Net decrease	
	No. of innovations	% of innovations	No. of innovations	% of innovations	No. of innovations	% of innovations
Production workers:						
0–100 employees	27	25	76	69	7	6
101–500 employees	32	32	65	65	3	3
More than 500 employees	25	47	22	42	6	11
Non-production workers:						
0–100 employees	39	37	65	62	1	1
101–500 employees	44	46	52	54	0	0
More than 500 employees	27	52	24	46	1	2

Reproduced with permission from Economic Council of Canada Discussion Paper No. 176, 'Preliminary Report: innovation and technological change in five Canadian industries' (Ottawa, 1980), by Dennis P. De Melto, Kathryn E. McMullen and Russel M. Willis, Table 14, p. 162.



GROWTH	GROUP SIZE	MEAN II
≤ o%	23	30.4
0–50%	28	46.0
≥ 50%	29	55.6
OVERALL	80	45.0

INNOVATION INDEX

Fig. 7.5 Distribution of innovation with growth in employment 1976–79. *Source: Innovation in small firms*, National Board for Science and Technology, Dublin. Preliminary Report, 10 October 1980 (final report published 1981).

the employment generation effects are a function of firm size, i.e. a greater percentage of innovations are associated with employment gains in the smaller firms.

Finally, a study undertaken in the Republic of Ireland by and for the National Board for Science and Technology, also indicated a positive relationship between innovativeness and employment growth (NBST, 1980). The study, which involved constructing an 'innovation index' (II) for each of 120 firms employing below fifty (75 per cent of all firms in Ireland employ less than fifty), found that negative employment growth was correlated with lack of innovativeness, while high employment growth was strongly associated with innovativeness. The period covered by this research was 1976–79, and the results relating to employment are summarized in Fig. 7.5.

Other interesting aspects of this study are:

- firms over thirty years old tended to be less innovative than younger firms;
- innovativeness demonstrated some regional variation;
- rate of growth in turnover was strongly correlated with innovativeness.

The above three sets of results would once again support the contention that while new small firms in general can generate significant new employment opportunities, at least in the long term, it is probable with the formation of technologically innovative new firms that the greatest long-term employment growth possibilities lie.

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8 INNOVATION, SMALL FIRMS AND REGIONAL DEVELOPMENT

Introduction

Traditionally, regional industrial policy has focused primarily on offering various planning, property and financial incentives to firms to locate branch manufacturing plants in the so-called development regions, as well as offering assistance to ailing (usually traditional) industries already located in these regions. Since the onset of the current recession in the early 1970s, however, few firms appear to be expanding and seeking new production capacity; on the contrary, the emphasis increasingly appears to be one of rationalization and retrenchment, with many branch manufacturing plants being reduced in size, merged or closed down completely.

As a means of increasing local levels of technological sophistication, the encouragement of branch manufacturing plants appears to have been disappointing in most countries, and Townroe (1975), for the UK, has pointed to the lower levels of technical sophistication found in new regional branch factories when compared with their parent companies. Oakey (1979) sees this as being consistent with product life cycle theory; he suggests that the development of new products will normally occur in or near the parent plant, and that branch plants will receive more or less exclusively mature products to manufacture.

Given the technology-led structural nature of the current world economic crisis (Rothwell and Zegveld, 1981), and in the light of the above discussion, it would appear that potentially greater long-term gains in regional development might be obtained through the encouragement of independent firms in the regions, and the establishment of new firms; in particular, emphasis should be placed on assisting innovative small firms and the generation of new technology-based firms.

Innovation as a regional phenomenon

Before attempting to discuss the role of small firms in regional innovation/development policy, it is first necessary to pose the question 'is innovation, and particularly small firm innovation, a regional phenomenon?'. This issue has been the subject of research over a number of years in the UK by workers at the Centre for Urban and Regional Development Studies at the University of Newcastle, and this section draws on their findings. Their analysis is based on approximately 300 important innovations introduced by UK firms between 1965 and 1978. While these data relate exclusively to the UK, the kinds of regional variations they indicate probably also occur in most other advanced countries, at least within Europe.*

Taking first multi-plant companies, Oakey *et al.* (1980) suggest that the branch plant population has not produced its expected share of innovations:

> For the 192 innovations recorded in multi-site companies and providing adequate data for analysis, 126 were first introduced in branch plants as compared to headquarters factories, or in a ratio 2:1. The significance of this ratio depends on the population of branches to headquarters factories in the population at large. Gum and Gudgin's (1977) sample of admittedly large corporations suggests a ratio of branch plants to manufacturing head offices of approximately 6:1. Smith (1979) in his work on ownership and control of manufacturing industry in the Northern Region of England suggests a ratio of 4.5 branch plants to one headquarters plant. But perhaps the most reliable data, which covers all establishment size bands for Scotland by headquarters and branch plant activity suggests for indigenous industry a ratio of 3.4:1 (Cross, 1979).

Based on the data in Table 8.1, Oakey *et al.* go on to state:

> The suggestion, therefore, is that new techniques are more likely to be developed and manufactured on site if the plant concerned is a headquarters factory, while branch plants are more likely to 'import' products developed elsewhere. Thus, it appears that regions with large numbers of headquarters plants are more likely to contain both originators and first commercial manufacturers of innovations.

Operating on the same data set, Oakey (1979) has shown that while the South Eastern planning region of the UK is the most significant source for innovations first exploited in other areas, 57 per cent of the specifications developed outside the factory of first manufacture were put into full commercial production within the South East. In fact, for all UK planning regions, Oakey found a strong tendency for short-distance *intra*-regional

* As we saw earlier, innovation in the US semiconductor industry, in which technology-based small firms played a key role, was most definitely a regional phenomenon.

Table 8.1 Site of development and first commercial application by plant status within multi-plant companies

	Headquarters factory	Branch factory
Developed on site	54 (82%)	73 (58%)
Developed at other plant in group	12 (18%)	53 (42%)
Total	66	126

Source: Oakey *et al.*, 1980.

movement of innovations. Significantly, UK company group headquarters and high level research and development functions are concentrated in the South East of England (Goddard and Smith, 1978; Buswell and Lewis, 1970).

Two important implications of the above results are:

– given the apparently limited mobility of new innovations between regions, then this highlights the importance of indigenous regional innovative performance and hence regional innovation policies;
– the location of centres of R & D expertise is clearly a significant factor in determining the location of first commercial manufacture of innovations.

Turning now to the regional distribution of innovations, Table 8.2, taken from Oakey (1979), shows the regional variation in the number of workers per innovation and the number of plants per innovation. It shows quite marked differences between regions in apparent innovativeness. These differences might, however, be as much as the result of regional variations in industrial structure as of variations in regional innovativeness. In a more sophisticated analysis Oakey *et al.* (1980) have normalized the data, taking into account regional industrial structure and the national innovation rate by sector. Their results are shown in Table 8.3, which suggests an industry structure advantageous to innovations in the South East region.

The question of innovation by size of firm was mentioned earlier, and Oakey *et al.* (1980) show that 71 per cent of the total were first introduced into plants employing more than 200. Further, 77 per cent of all innovations were attributed to plants which were part of multi-plant organizations. The small (< 200 employee) establishments were responsible

Table 8.2 No. of workers and no. of plants required to produce one survey innovation in the planning regions

	Scotland	North	N. West	York + H	Wales + M	E. Mids.	W. Mids.	E. Anglia	S. East	S. West	British Average
No. of workers per 1,000 innovation	33.8	22.4	33.0	31.8	55.9	32.4	32.7	15.7	20.4	19.5	29.1
No. of plants per innovation	241	109	228	244	332	253	217	124	179	144	196

Source: Oakey (1979).

Table 8.3 The effect of industrial structure on regional innovation performance (measured in terms of total manufacturing employment)

	(a) Actual innovations	(b) Expected innovations (regional)	(c) Expected innovations (national)	(d) Residual (a–b)	(e) Expected variation in innovation due to industrial structure (b–c)
Development areas	46	58	57	–12	1
South East region	98	81	72	17	9
Other regions	143	148	158	–5	–10
Great Britain	287	287	287	0	0

Notes:
(a) The actual number of innovations recorded in each region with the actual regional industrial structure and the actual regional innovative performance.
(b) The expected number of innovations in each region given the regional industrial structure and the national innovative rate by sector.
(c) The expected level of innovations by region based on the region's share of GB manufacturing employment and the national level of employees per innovation.
N.B.: Figures rounded to nearest whole number.
Source: Oakey *et al*. (1980).

for 60 per cent of all innovations credited to single-plant, independent enterprises, while only 20 per cent of multi-plant innovations were credited to the same plant size group. These results imply either that small independent single-plant firms are particularly innovative, or that there are relatively fewer large single-plant independent enterprises.

Once again, using detailed normalized procedures, Oakey *et al.* have calculated the regional distribution of innovations according to firm size (Tables 8.4 and 8.5). It is apparent from these data that significantly more plants, both large and small, produce innovations in the South East than expected, while in the Development Areas small firms perform precisely as the data average would suggest, but large firms perform rather poorly. This might be taken to suggest that small plants are better suited to regional innovations – especially independent small plants – than are larger plants.

Small firms and regional development

The discussion above suggests that independent small firms might be better vehicles for regional innovation policy than the branch manufacturing

Table 8.4 Small-plant expected and actual regional innovative performance

	(a) Actual innovations	(b) Expected innovations	(c) Residual (a–b)
Development areas	13	13	0
South East region	38	26	12
Other regions	32	44	−12
Great Britain	83	83	0

Notes:
(a) The actual number of innovations recorded in small plants with the regional small-plant population and the actual regional innovative performance in small plants.
(b) The expected number of innovations in each region given the regional small-plant population and the national level of innovation in small plants.
The division into small and large plants is made at the level of 200 employees. This follows the cut-off adopted by the Bolton Committee to define small firms.
N.B.: Figures rounded to nearest whole number.
Source: Oakey *et al*. (1980).

Table 8.5 Large-plant expected and actual regional innovation performance

	(a) Actual innovations	(b) Expected innovations	(c) Residual (a–b)
Development areas	33	42	−9
South East region	60	48	12
Other regions	111	114	−3
Great Britain	204	204	0

Notes:
(a) The actual number of innovations recorded in large plants with the regional large-plant population and the actual regional innovative performance in large plants.
(b) The expected number of innovations in each region given the regional large-plant population and the national level of innovation in large plants.
The division into small and large plants is made at the level of 200 employees. This follows the cut-off adopted by the Bolton Committee to define small firms.
N.B.: Figures rounded to nearest whole number.
Source: Oakey *et al*. (1980).

plants of large firms. This contention is supported by the fact that large companies tend to establish centralized R & D laboratories, thus localizing innovative effort, often at the site of the parent establishment, which can make it difficult for branch plants to innovate in response to local market needs.

The markets of independent small firms are often localized, thus making small firm innovation largely a local phenomenon. This is well illustrated in the UK in Table 8.6, taken from Johnson and Cathcart (1980). It compares the sales in the Northern Region of the UK, as a percentage of total sales, of sixty new local small firms, and eighty-three plants belonging mainly to well-established firms (many being 'immigrant' branch plants). Clearly the new small businesses have significantly stronger links with local markets than do the established (branch) plants.

Table 8.6 Sales in the Northern Region by new local firms and established plants

Sales in Northern Region as a % of total sales	Number of new firms	Number of plants in 'Morley' sample*
0–5	7 (12%)	44 (53%)
6–25	8 (13%)	19 (23%)
26–75	15 (25%)	10 (12%)
76–100	30 (50%)	10 (12%)

* R. Morley, 'Employment, Investment and Regional Policy in the Northern Region', North of England Development Council, Newcastle, 1976.

Source: P. Johnson and G. Cathcart, 'Manufacturing firms and regional development: some evidence from the Northern region', in A. Gibb and T. Webb (eds), *Policy Issues in Small Business Research*, Teakfield Ltd., Farnborough, Hants, 1980.

Other reasons for favouring independent small firms in regional development policy generally are:

- Small firms are often seen as a buffer to sharp fluctuations in employment. In the UK, for example, Fothergill and Gudgin (1979) found that during a period of severe industrial stagnation in the 1970s, small manufacturing firms have been more buoyant than their larger counterparts;
- a related case is sometimes made for the superiority of small local firms over manufacturing divisions or branches of large firms with headquarters elsewhere, in providing employment stability in under-industrialized

regions. This position is based on the disappointing results of regional industrialization policies in a number of countries. While providing short-term relief of local unemployment when enticed by government subsidies to locate in the regions, branch manufacturing plants were hardest hit when the recession came. Gronhaug, Frederiksen and Vatne (1979) have provided convincing evidence for this phenomenon in the Jorpland and Rjaikan areas of Norway;

- it is also often argued that governments would do better to support local small firms because of their more even balance between direct and indirect labour (branch plants employ fewer high-level managers and technical specialists) and firmer commitment to local interests. This offers greater possibilities for a more balanced growth in the range of local skills. Johnson and Cathcart (1980), utilizing data from the Northern Region of the UK, have indicated that this can also affect regional 'fertility', i.e. the propensity of local firms to spin-off new local small firms. None of the founders in their study (of sixty new firms) had been unskilled workers in their previous employment and, significantly, none came from immigrant (branch plant) industry.

Small firm innovation as a regional phenomenon was discussed earlier, as was the close relationship of small independent firms with local markets. In the so-called development areas in most countries, local industry often consists of rather old firms operating in traditional technologies and markets (e.g. textiles, shipbuilding, steel, heavy engineering). This means, in turn, that many small suppliers will be producing quite conventional, low technology goods demanding little real technological innovation.

Close and stable links with one or two very large firms can also create a state of dependency in small suppliers, which effectively shields them from market and technological changes elsewhere. Thus, Gibb and Quince (1980) found, in a study of twenty-eight local suppliers to four large companies in the North East of England, that extreme dependency often led to a limited perception of the market and competitive environment that rendered small firms in that position more vulnerable to changes in the larger environment.

Rothwell (1979), in a study of the factors affecting competitiveness in the European Agricultural engineering industry, found that total reliance on local markets often resulted, in the longer term, in technological backwardness in the smaller firms. Small firms, supplying local farmers with conventional equipment, and successfully selling all they could make, failed to detect changes in technology introduced by their larger, less parochial (often foreign) competitors. Thus, the farmers continued to buy smaller, conventional items locally, and bought the more sophisticated equipment elsewhere; this effectively shielded local suppliers from developments that could eventually threaten their livelihood. At the very least, it gave them little or no incentive to innovate. Further, machines designed for specific local farming conditions often lacked sufficient flexibility to enable them to be used elsewhere, which effectively limited their market.

Thus, it appears that while small independent firms can be highly innovative, the number and nature of their innovations will depend to a large extent on the technological requirements of local markets. Some regional variations in type of innovation (by industrial sector) in the UK are listed in Table 8.7, for firms of all sizes, which provides some indication of regional industrial specializations (Oakey, 1979). This can present planners in regions characterized by traditional, and perhaps declining, industries with real problems if they wish to stimulate local small firm innovation and might imply the need for a dual strategy, i.e. one that involves attracting large, high technology firms to the region while at the same time encouraging the growth in numbers of small local suppliers. A second strategy would be for local authorities to adopt innovation-oriented procurement policies to stimulate supplier innovations (see Rothwell and Zegveld, 1981).

Some regional initiatives

In this section we shall discuss a number of innovation-oriented regional initiatives in several countries, taking each country separately.*

The UK

Assistance for regional innovation and industrial development is generally available in most countries from central government, and it is often administered at the local level. It would be out of place here to attempt to offer a detailed listing and description of all UK government initiatives towards regional industrial development and schemes to stimulate, and assist in, industrial innovation. Schemes for preferential regional assistance for industry in the UK are described in a recent Department of Industry booklet (DOI, 1980) and measures to assist innovation in small firms are described in chapter 9.

Before describing specific regional innovation and small firm initiatives,

* For detailed trends in the services offered by the collective industrial research infrastructure in its provision of assistance to small firms in a number of countries, see R. Rothwell (1980).

Table 8.7 Regional innovation by industrial order heading

		Agriculture, etc. 01–03	Mining & q. 101–109	Food, drink, etc. 211–240	Coal & petrol prods., 261–263	Chemicals & allied inds., 271–279	Metal manufacture 311–323	Mechanical eng. 331–349	Instrument eng. 351–354	Electrical eng. 361–369	Shipbuilding, etc. 370
Order		I	II	III	IV	V	VI	VII	VIII	IX	X
Scotland	A	1	0	0	0	2	0	9	1	1	0
	B	5.0	–	–	–	10.0	–	45.0	5.0	20.0	–
	C	7.5	5.0	14.6	0.32	4.1	6.4	13.9	2.6	8.8	6.3
Northern	A	0	0	1	0	3	2	5	0	3	4
	B	–	–	4.8	–	14.3	9.6	23.8	–	14.3	19.0
	C	3.72	11.1	7.3	0.6	10.9	10.5	14.0	1.1	12.0	10.3
West	A	0	0	1	1	7	0	9	1	5	0
	B	–	–	3.0	3.0	21.2	–	27.3	3.0	15.1	–
	C	0.2	1.4	10.5	0.8	8.9	2.3	11.4	1.0	9.8	0.9
Yorks & H	A	0	0	0	0	2	1	10	2	0	0
	B	–	–	–	–	8.3	4.2	41.7	8.3	–	–
	C	4.6	10.6	11.0	0.7	12.6	12.1	12.3	0.7	4.1	0.9
Wales	A	0	0	0	0	0	2	2	0	0	0
	B	–	–	–	–	–	33.3	33.3	–	–	–
	C	8.1	12.7	5.8	1.7	5.0	24.8	8.1	1.4	10.5	0.5
Mids	A	0	0	1	0	1	1	9	0	2	0
	B	–	–	5.3	–	5.3	5.3	47.4	–	10.5	–
	C	6.2	11.4	8.2	0.4	4.6	6.5	13.4	0.8	6.7	0.2
Mids	A	0	0	0	0	0	2	10	2	7	0
	B	–	–	–	–	–	6.1	30.3	6.1	21.2	–
	C	3.1	2.3	5.5	0.1	1.9	11.7	12.2	0.7	10.4	0.0
Anglia	A	1	0	0	0	2	0	2	3	4	0
	B	7.8	–	–	–	15.4	–	15.4	23.1	30.8	–
	C	22.5	1.2	20.3	0.0	4.8	1.0	14.6	2.4	11.8	1.7
East	A	1	0	0	2	13	0	19	17	25	1
	B	1.0	–	–	2.0	13.1	–	19.2	17.2	25.3	1.0
	C	4.3	0.6	8.5	0.49	6.4	1.9	12.1	3.4	15.6	2.0
West	A	0	1	1	0	2	1	5	3	2	1
	B	–	4.3	4.3	–	8.7	4.3	21.7	13.0	8.7	4.3
	C	11.4	2.6	14.3	0.0	3.7	1.6	14.0	3.6	10.7	4.65

A = Innovations
B = Percentage regional innovations
C = Percentage regional employment.

Vehicles 380–385	Metal goods *not* elsewhere, 390–399	Textiles 411–429	Leather goods & furs, 431–433	Clothing & footwear 441–450	Bricks, pottery, glass, 461–469	Timber, furniture etc., 471–479	Paper, printing & publishing, 481–489	Other manufacturing inds., 491–499	Regional Total	
XI	XII	XIII	XIV	XV	XVI	XVII	XVII	XIX	N	%
1	0	1	0	0	0	1	0	0	20	6.9
5.0	–	5.0	–	–	–	5.0	–	–		
5.9	4.7	10.3	0.4	5.0	3.0	3.4	7.4	2.7		
0	0	0	0	0	1	0	1	1	21	7.2
–	–	–	–	–	4.8	–	4.8	4.8		
2.6	3.4	5.6	0.4	7.3	3.3	2.7	4.7	3.3		
1	0	4	0	0	1	0	1	2	33	11.3
3.0	–	12.1	–	–	3.0	–	3.0	6.1		
11.2	4.9	12.2	0.6	6.4	3.8	3.3	7.3	4.6		
2	1	3	0	1	0	0	0	2	24	8.2
8.3	4.2	12.5	–	4.2	–	–	–	8.3		
5.9	10.1	15.6	0.7	6.0	4.2	3.7	4.7	2.6		
0	0	0	0	0	1	1	0	0	6	2.1
–	–	–	–	–	16.7	16.7	–	–		
7.9	6.9	5.0	0.4	4.9	3.5	2.62	3.8	7.4		
2	0	1	1	0	0	0	0	1	19	6.5
10.5	–	5.3	5.3	–	–	–	–	5.3		
8.4	5.2	18.5	0.6	10.4	3.9	3.0	4.7	3.7		
4	1	2	0	0	4	0	1	0	33	11.3
12.1	3.0	6.0	–	–	12.1	–	3.0	–		
18.8	17.1	10.6	0.5	0.2	6.8	1.8	3.0	5.0		
0	0	1	0	0	0	0	0	0	13	4.5
–	–	7.8		–	–	–	–	–		
8.8	2.9	1.4	0.0	5.5	3.3	5.0	9.6	6.3		
7	1	2	1	0	2	3	2	3	99	34.0
7.1	1.0	2.0	1.0	–	2.0	3.0	2.0	3.0		
10.1	6.5	1.1	0.6	4.4	2.8	5.0	12.9	5.4		
4	1	0	0	1	0	0	1	0	23	7.9
17.4	4.3	–	–	4.3	–	–	4.3	–		
13.5	4.5	2.9	0.7	4.9	2.9	4.3	8.9	5.0		
								Total	291*	100

* Research & Development departments and non-British plants excluded.

Source: Oakey (1979).

it is interesting to consider the results of a recent survey of 158 local authorities in England and Wales, which elicited details of their policies and practices towards small firms (Wilson, 1980).* These results showed that:

> A large number of local authorities (45) had no small business programme at all, nor did they give any recognition in their policies to the different needs of large and small firms. The remainder claimed to have either a specific small business programme (43) or an approach that differentiated to some extent between small and large firms (26).

Table 8.8 lists the range of services provided by the forty-three local authorities under specific small business programmes. Authorities with non-specific, but nevertheless differential (by firm size) programmes, 'based their assistance on indirect measures such as the orientation of their employment policies to small business, the encouragement of small premises construction and assistance with finding small factory units'.

The table shows that local authority schemes are tailored very much towards the provision of premises and workshops. Justification for this emphasis is provided in the results of a variety of surveys undertaken by seventeen of the forty-three authorities mentioned above, in which small firms were asked to identify their major problems. The factor 'lack of suitable premises' emerged as the most significant. It must, however, be emphasized here that the survey included both service sector and manufacturing firms.

Some recent small business initiatives

(i) General assistance to small firms

Enterprise zones

In 1980 the government announced the establishment of the so-called 'enterprise zones' in eleven declining inner-city areas in the UK. The aim of the enterprise zones is to stimulate the regeneration of decayed inner city areas through attracting firms to relocate, and new small firms to

* It is interesting, in relation to our earlier discussion, that the same author provides convincing evidence, from a survey of 200 companies (service and manufacturing) in a London borough, for the relatively high dependence of small firms on local markets. The survey also showed that this dependency was greatest in the case of the youngest firms. This suggests that the nature of the local market can significantly affect the type of new small firm that is likely to spring up in that particular locality.

Table 8.8 Actions under specific small business programmes

Actions	Responses	
	Frequency	%
Providing small premises and workshops	42	97.7
Providing information; directory of services	17	39.5
Industrial liaison officer; councillors	14	32.6
Grants	12	27.9
Loans and loan guarantees	12	27.9
Liaison with Co. SIRA, SFIC, ARC, etc.	11	25.6
Provision for small businesses in structure plans	8	18.6
Providing sites for small businesses	5	11.6
Trade promotion	4	9.3
Key worker housing scheme	1	2.3
Employee training assistance	1	2.3

Source: P. Wilson (1980).

grow, there. Recognizing that high rateable values in large cities can not only dissuade small firms from relocating or growing there, but can also force them to move out altogether, for the first ten years businesses in the zones will be freed from rates. Recognizing further that local planning processes can be lengthy and cumbersome, the enterprise zones will be largely freed from red tape, making the planning process easy and quick. Firms locating in the current enterprise zones will also qualify for the battery of local authority and central government schemes currently available to assist small firms generally.

The St. Helens Trust

This is a joint venture, initiated by Pilkington Brothers, the largest local manufacturer, and taken up by the local authorities, Chamber of Commerce, industry, banks and unions (Aitken and Pearson, 1980). Its objectives are to increase prosperity and employment opportunities in the St. Helens district by creating an environment favourable to new business ventures by both new businesses wishing to start up, and existing ones wishing to expand.

Services provided include:

- major participating organizations attempting to provide a market;
- professional consultancy, particularly accounting, the sciences and engineering;
- loans, or seed capital, or advice on how to raise funds commercially;
- location of suitable premises by close liaison through local government and private developers;
- market assessment assistance for new developments and products;
- liaison with local colleges and sources of training;
- expert management assistance.

The aim of the Trust is to assist the entrepreneur to succeed, rather than to attempt to run the business for him. In the first fourteen months of operation, 250 small businesses approached the Trust, and most received assistance in one form or another.

B.S.C. Industries

This is an initiative by the British Steel Corporation to find new jobs to fill the gaps left by closing steel works in company towns in Scotland, Wales and the North. Figure 8.1 outlines the steps in the process of attracting new business – hence new jobs – to these areas (Westlake, 1980).

The success of this venture can be gauged from the fact that it generated

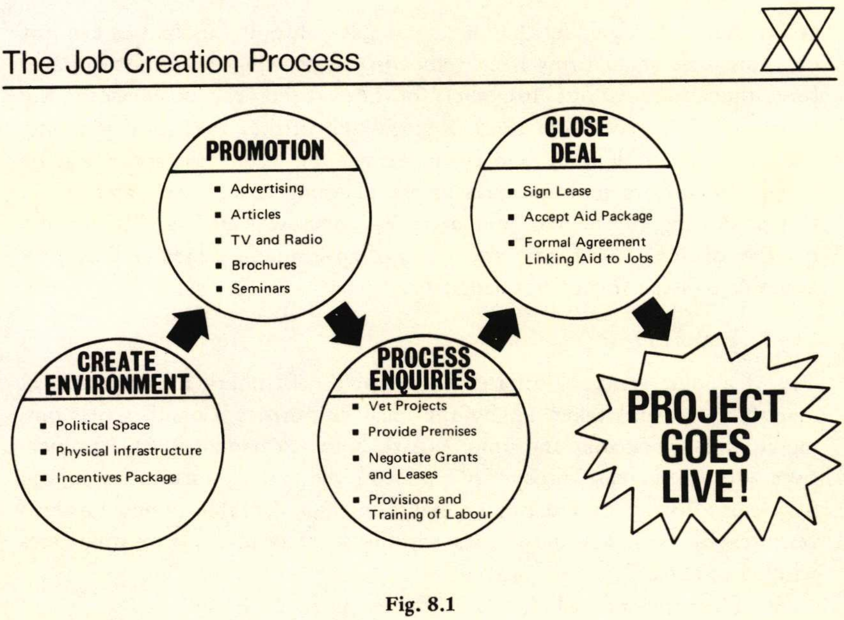

Fig. 8.1

3,000 jobs in 1978, 6,000 in 1979 and had an expectation of 10,000 in 1980.

B.S.C. Industries itself spun off a private concern, Job Creation Ltd., in 1980. In addition to carrying out the practices evolved at B.S.C., the new firm is advocating the setting-up of Small Business Enterprise Centres. This involves promoting an approach combining property development, licensing arrangements and business management with an emphasis on simplicity, cost-effectiveness and speed. It will involve approaching a consortium of business sponsors, financial institutions, local and regional authorities and other local organizations.

The consortium will undertake the conversion of local buildings; Job Creation Ltd. will provide an experienced management team. Currently two centres are being planned for major cities. While each centre will cater for a wide range of businesses, particular emphasis will be placed on encouraging technology-based businesses.

The London Enterprise Agency

The London Enterprise Agency, at the London Chamber of Commerce and Industry, was established by a group of nine large companies to help small firms. It provides a variety of services including premises and technical, management and marketing services. In 1980 LENTA launched a drive to attract new and potential innovators. This involved organizing an exhibit on innovation and new product development at the Business to Business Exhibition, Earls Court, 8–12 June, 1980. The main features of the LENTA exhibit was a display of services available to innovators from itself, as well as organizations such as the Design Council, NRDC and universities. There was also a Business Opportunities section in which seven new products were presented that needed financial backing, management expertise or other arrangements for their successful marketing.

LENTA has also created a 'marriage bureau'. This will attempt to:

- create new businesses by bringing together financial backers and people with viable, developed business propositions;
- bring together existing businesses requiring and offering capacity;
- attempt to identify suitable successors for retiring, small firm entrepreneurs;
- utilize the pool of skills available in recently retiring or redundant executives to assist small firms on a part-time or temporary basis.

New Enterprise Programme

This is a joint Manpower Services Commission/university initiative (London Business School, Manchester Business School, Durham University Business

School), scheduled to begin in 1981. It is designed specifically for people who are committed to setting up their own business which will employ others. It involves an initial residential period at university followed by a feasibility study by each would-be businessman at the intended location of his business start-up.

Innovation-oriented initiatives

The Merseyside Innovation Centre

The MIC is a recent initiative, still in its pre-construction phase. It grew out of an examination of the possibilities for closer liaison between Liverpool University's research activities and the economic development objectives of the Merseyside County Council.

It is proposed to form a company called the Merseyside Innovation Centre Ltd., which will have the following objectives:

– to provide a service to companies, particularly in the Merseyside area, which could benefit from the use of the research and development expertise and facilities of the University and Polytechnic;
– to provide the means whereby research in the University and Polytechnic can be directed more effectively to meeting the identified commercial need for the development and successful application of innovations in product design, production methods and the use of materials for the benefit of industry;
– to provide a focus for innovative activity on Merseyside offering information and advice on the activities of research and development agencies linked to government departments, higher educational establishments and private companies.

It is intended to secure adequate premises so that the MIC can provide rented accommodation to companies and organizations which can benefit from close proximity to, and contact with, the MIC, the University and the Polytechnic.

Science Parks

Science Parks are intended as sites in which high technology companies can prosper, and several privately and publicly sponsored parks are currently under construction. The first of these is the Genesis Science Park near Warrington. This consists of a two-storey building, having 4,300 square metres of space for laboratories and offices, in units of between 37 square metres and 500 square metres. A quarter of the first phase – completed in 1980 – has already been let by the Warrington Development

Corporation, to companies involved in computing, medical equipment and consultancy.

The UK's latest, and biggest, private industrial park for science-based companies – called Aztec West – is being constructed on the outskirts of Bristol, close to the M4 and M5 motorways. It will include 150,000 square metres of accommodation for factories, laboratories and warehouses, and 50,000 square metres of offices, hotel and recreational facilities.

A science park is currently under discussion for London, which would attempt to foster, in particular, the development of companies manufacturing products that incorporate microelectronic technology. It would also provide a 'seed-bed' unit, in which people seeking to develop a new business venture are provided with suitable facilities on short lease or licence conditions.

University Science Parks

The best known of these in the UK is the Cambridge Science Park, founded by Trinity College and sited on the outskirts of Cambridge. The park includes 14 small companies – at least three of which have been spawned by Cambridge University – working on a variety of science-based activities including computer-controlled laser systems, new scientific instruments, veterinary vaccines and a supermarket for rare metals.

The Polytechnic of the South Bank (London) has recently drawn up plans to set up a £1 million Techno-Park, which will act as a 'nursery' for new small businesses. It would operate analogously to a teaching hospital, providing 'clinical' training for students, who would be able to interact with the businesses and become involved in solving management and technical problems. The small businesses would benefit from the wide range of facilities and expertise available within the polytechnic. It is intended that the Techno-Park will be ready for use in 1983.

Although relatively few local small firm/innovation schemes have been described above, it is clear that in the UK interest in stimulating the growth of new technology-based small firms (NTBFs) is both increasing and widespread. The fact that initiatives have derived from local authorities, institutions of higher education and private industry, or from some combination of two or more of these, appears to offer some cause for optimism concerning the future growth of NTBFs in the UK.

West Germany

There appears to be a growing trend within West Germany towards greater regional (Länder) autonomy in matters of economic policy, which is paralleled by attempts to formulate effective policies for the regionalization of assistance towards innovation (Recker, 1981). Research in West Germany on the spacial impact of research and technology policy has shown that there are considerable differences between the innovation policies and potential of firms in densely settled regions and those in regions that are structurally weak. SMEs, which are located to an above average extent in the weaker regions, experience severe difficulties both in gaining access to scientific and technological information and in attracting technical specialists. They also have problems in obtaining capital to fund R & D projects, including federal government cash.

Although West Germany has, as yet, no detailed programme of regional innovation-oriented initiatives, several such initiatives do already exist. These include:

- opportunities for consultations on technology through regional consulting bodies;
- subsidies for R & D personnel, especially for small firms in deprived areas;
- improved utilization of regional higher-educational facilities and autonomous research bodies, and in particular the increased provision of technology courses and improvements in technology transfer;
- the extension of opportunities for vocational training in order to improve regional human capital.

On the basis of the realization that insights into the regional conditions of innovation in West Germany have so far been fragmentary, the Federal Ministry for Regional Planning, Building and Urban Development has begun a series of research projects, on which future policy initiatives will be based, in the following areas:

- analysis and case studies on the regional adaptation and diffusion of technology;
- indicators on regional innovation performance;
- regional distribution of qualified R & D personnel;
- the significance of newly-established colleges in rural areas for the support of industrial innovation.

The Netherlands

Regional innovation policy in the Netherlands is based on the recognition that outside those areas where there is a concentration of population, industry, higher education, R & D establishments and other services, the innovation climate will be rather poor. Such a depressed innovation climate exists most notably in the three Northern Provinces, the province of Limburg in the South and the area of Twente in the East. Regional innovation policy in the Netherlands is thus geared towards establishing an 'adequate innovation infrastructure' (van Driem, 1981).

In several regions, interesting innovation-oriented initiatives have recently been taken. For example, in the Northern Provinces, a Centre for Enterprise Planning and Innovation has been set up by an Employer's Federation with financial assistance from the Northern Development Fund. The Centre enables industrial firms to draw upon the services of consultants in the fields of business planning, market research and new product selection. Plans have also been drawn up in several areas for Business and Technology Centres and other innovative forms of providing business premises combined with centrally-offered advisory services on a single site. In Twente, where a Technological University is located in the city of Enschede, the already close co-operation between industry and University in the field of microelectronics is soon to be extended through the establishment of a Microelectronics Centre. At all Technological Universities offices for Technology Transfer have been instituted with Government aid.

The provinces (and municipalities) have only very limited possibilities directly to assist enterprises financially. All provinces are, however, in the position to improve the economic infrastructure, and they also have important roles to play in the field of physical planning and environmental policy. Recently all provinces have been asked to create a special office for industrial policy and innovation in an attempt to improve information flows and co-ordination between central and provincial government.

Regional Development Companies

Perhaps the most important instrument for the promotion of innovation in the regions is the Regional Development Company. These were conceived as institutions which could help to initiate new, innovative activities in the regions, both by providing co-ordination, consultancy and information (i.e. an 'innovation infrastructure') and by means of equity participation. There are four Regional Development Companies (RODs, according to the Dutch abbreviation) in the Netherlands:

- the Northern Development Company (NOM), which operates in the provinces of Groningen, Friesland and Drente (9,000 km^2, 1.6 million inhabitants), i.e. with roughly one-tenth of the population;
- the Overijssel Development Company (OOM), which operates in the

province of Overijssel which includes the region of Twente (3,900 km^2, 1 million inhabitants);
- the Gelderland Development Company (GOM), operating in the province of Gelderland (5,100 km^2, 1.7 million inhabitants);
- the Limburg Industry Bank (LIOF), in Limburg (2,200 km^2, 1.1 million inhabitants).

The ROMs were instituted between 1974 and 1978. All four of them are Limited Companies, the shares being held by Central and/or Provincial Government. The Ministry of Economic Affairs covers the running cost (staff, offices), for 100 per cent in the case of NOM, and between 50 per cent and 75 per cent for the others.

These Companies aim to improve the socio-economic structure of their region, and their activities are directed towards industrial enterprises and the commercial services sector. They are staffed by businessmen with a wide variety of commercial and industrial experience.

The main activities of the ROMs are:

- to stimulate initiatives to start new enterprises in the industrial or commercial service sector;
- to attract investors from the western part of the Netherlands and from other countries;
- to assist foreign and local investors with site selection and technical, financial and commercial arrangements;
- to stimulate innovation in existing companies in the region;
- to assist existing companies with financial problems.

A ROM is required to act as a comprehensive information bank on supply channels, possible partnerships, government grants, capital resources, know-how and several other factors in investment decisions and business development. They effectively operate at the interface between government and the free market enterprise. They are risk-taking in character. Their employees are not civil servants, and they all have extensive business experience.

The ROMs conduct their business directly with individual businessmen, and some of them can take equity shares in innovative enterprises. Today, the ROMs consider young and small enterprises to be their most important field of activity, partly because large firms have their own means of attracting new know-how and technology, as well as of government support, and partly because the former are seen as the most suitable vehicles for instituting regional policy.

While only the Regional Development Companies are described in detail here, since these represent the most recent and innovative experiment in the Netherlands, it is worth mentioning that a well-established network of advisory agencies also exists under the auspices of the National Industry Service. Finally, in the Netherlands, a marked lack of mutual collaboration by firms in the regions, especially between large and small firms is apparent, and no large firm initiatives such as the St. Helens Trust in the UK appear to exist.

The Republic of Ireland

Regional policy in Ireland, as in other countries, has consisted mainly of 'traditional' measures such as cash grants to industry, the provision of factory sites, regional training services, etc. The Industrial Development Authority is the main industrial development agency in Ireland with a budget in 1980 of £155 million. It has regional offices in all regions and, since 1972, it has produced five year plans on a regional basis which have served as a principal source for regional development planning by other organizations.

Undoubtedly, the most interesting innovation-oriented regional initiative in Ireland was the establishment of the Shannon Free Airport Development Company in 1976, and the subsequent establishment there of an Innovation Centre. The objectives of the SFADCO were twofold (Brady, 1981).

1. To bring out, through intensive action, the full potential of small indigenous industry.
2. To devise and test ideas, strategies, and systems to stimulate the establishment and growth of small indigenous industry.

The project was seen as a pilot exercise, the results of which would be evaluated to determine the suitability of extending such an intensive drive to other regions. SFADCO's evaluation of the nature of small Irish industry led it to a definition of the necessary characteristics of the system of programmes which could successfully foster it. The system must be:

1. comprehensive – it must take account of the full environment impacting on the success or failure of small industry;
2. simple – for the small industry manager it must involve few external contacts, no overlapping or confusion between agencies, minimum red tape;
3. locally available – for convenience, quick response, personal confidence, sense of commitment, and accountability of results.

Under these guidelines, forty-seven programmes were established, many running jointly with other agencies. The forty-seven programmes were classified into six groups:

1. Influencing people to start, expand, or support small industry.
2. Improving the availability of finance.
3. Improving the physical environment for small industry.
4. Raising the standards of management and technology.
5. Improving the marketing performance of small industry.
6. Adding to the range of products of small industry.

In the Shannon region, job approvals in small industry went from 226 in 1977 to 2,120 in 1979, corresponding to an increase to 20 per cent from a 10 per cent share of the total small industry job approvals in the country as a whole. SFADCO concluded that the pertinence and effectiveness of any one programme in contributing to these results depended not only on its intrinsic content, but on its relationship to the system as a whole and on the attitudes and strategies inherent in the system. A number of key programmes were identified, including:

– Field services
– Business advisory services
– Provision of buildings
– Training
– Linkages with large industry
– Emigrant promotion
– Advertising and publicity
– Financial aids
– Innovation Centre
– Microelectronics applications centre.

The Innovation Centre, which was established towards the end of the project period, was seen as potentially the most effective single element of the whole programme. While the flow of new entrepreneurs in the region is inevitably limited, SFADCO are confident of sustaining their present job approval levels. To ensure the continued growth of these firms and achieve further job creation, innovation must play a greater role. SFADCO found that small indigenous industry had a relatively low level of technology and a limited capability to receive licences and form joint ventures. However, with the right environment and supports, small firms could and did adopt technological innovations.

These conditions pointed to the need for a new approach to technological innovation in small industry which it is intended the Innovation

Centre will fulfil. The Centre is to provide a total systems approach to the development of technology-based products for small industry, functioning as a one-step technology stop which will assemble and combine resources, people, money and product ideas for the development of small indigenous industry. The Centre would serve as a channel for the resources of a wide range of organizations in locating and cultivating specific product opportunities for small industry.

The Centre has been in existence for less than one year, so it is too early to evaluate its performance. It does, however, represent the most concrete example in the Irish context of the role of innovation in regional development.

Sweden

As a result of negotiations between national government, local and regional bodies (counties, local municipalities and unions) and, to some extent, companies of major regional importance, a number of Regional Development Companies were established in Sweden during the late 1970s (Olofsson, 1981).

As a group, the RDCs are expected to:

- set up new businesses, either on their own or in partnership with others, preferably small companies or private inventors;
- strengthen the equity of existing small companies that have potential for growth;
- support the development of managerial competence in companies towards which they have a commitment.

In practice, several of the RDCs have also been a significant resource in the reconstruction and regeneration of a number of firms that had entered a crisis stage.

In parallel with the establishment of the RDCs, the regional resources devoted to the support of small companies (less than 200 employees) have also increased, notably through the creation of regional development funds.

While the RDCs have already met with some success in increasing regional innovation and employment, it is, as yet, too early to comment on their effectiveness in stimulating and fostering longer-term innovative developments. The Swedes, however, have adopted the long-term view and are willing to wait before passing judgement on the RDCs. Finally, perhaps the major current problems of the RDCs, are their general lack of natural relationships with supportive, commercially experienced partners and their over-strong relationships with various political bodies.

France

In France a wide variety of measures exist to stimulate and foster innovation in small firms at the national level. Two notable trends during the past five years or so are (i) increased incentives for SMEs to utilize the services of the scientific and technological infrastructure, and (ii) increasing regionalization in the implementation of national innovation measures.

Since July 1972, following a law that installed the Regional Public Authorities, the regions in France have enjoyed greater political and economic autonomy. At the same time, the greater autonomy granted to the universities in 1968 is beginning to bear fruit at the regional level. For example, a number of university companies have been founded, such as those around the Technological University of Compiègne (Beauvais and Postal, 1981).

Italy

In Italy regional innovation policy rests primarily on the twin tools of R & D assistance and technology transfer. The system appears to be largely unco-ordinated with a marked lack of any clear national policy. Thus, regional innovation-oriented instruments generally arise as the result of local initiatives (Antonelli and Momigliano, 1981).

An interesting Italian initiative is *Finpiemonte*, a financial company jointly owned by Regione Piemonte (the majority shareholder) and a number of firms' associations and local government authorities. Initiatives taken to date include:

- The stimulation of technological supply. Based on the realization that many inventions generated in the R & D laboratories of large local firms (e.g. Fiat, Olivetti) remain unexploited by these firms, Finpiemonte has developed a programme to capitalize on these 'unwanted' inventions through spin-offs to local companies. Special financial grants are available to firms to assist them to buy and exploit the otherwise unused inventions.
- Stimulation of integrated technological structures. Finpiemonte has developed a concept of technology as a chain of services, i.e. information about new technologies and the training of manpower involved in using innovative new products or processes. Finpiemonte is thus attempting to acclerate the diffusion in the use of innovations by local small firms.
- Stimulation of technological consortia. Finpiemonte played a strategic role in the creation of a consortium of twenty-three small electronics

firms in the Piedmonte region. These firms, operating in a range of electronics technologies, have been induced to establish a centralized R & D laboratory.

- Provision of venture capital. In late 1981 Finpiemonte intended to make risk capital available to finance small firms or individuals having interesting technology-based projects. Participation will not depend on the basis of capital stock, but on ownership of the patents emerging from each project, and on the royalties the firms will pay on their exploitation.

USA

In the US a number of privately-funded initiatives have been taken towards stimulating innovation on a regional basis. Of note here are the Business and Technology Centres of the Control Data Corporation. These are based on the concept of the complementary nature of small and large businesses and on a belief in the innovative potential of independent technological entrepreneurs.

A BTC comprises a business location for small, technically-oriented companies, which has built-in scientific facilities and business services.

Each BTC is tailored to suit specific local requirements, but all contain a set of common elements:

- flexible office and laboratory space;
- building management;
- conference rooms, usually with teleconferencing capability;
- information centre;
- a learning centre for continuing business and technological education;
- a technology centre.

Additional facilities that can be made available include:

- model shops and laboratory facilities;
- word processing and printing services;
- personnel services, including labour relations;
- financial services, including insurance, accounting and sources of venture capital;
- legal and patent services.

Sites for the BTCs are selected where the needs of the business community and where the business climate are favourable. Participation must be sufficient to make the BTC a reasonable commercial proposition for all concerned, and a positive local government support programme for small businesses must be available.

On the basis of the above discussion and descriptions of local initiatives in a number of countries, it can be concluded that interest in stimulating small firm innovation at the local level is definitely on the increase in most advanced market economies. Policies designed to achieve this should not be formulated in isolation, but should be co-ordinated as part of a broader set of national innovation policies; they should, however, enjoy a high degree of local autonomy in their detailed interpretation and implementation; they must be flexible with respect to local economic and other variations; governmental bodies should also seek to stimulate private local initiatives. Finally, such initiatives must be simultaneously long-term in perspective (and thus divorced from the often cynical, and nearly always short-term, dictates of party politics) and flexible with respect to changing social, economic and technological circumstances, i.e. to changing threats, needs and opportunities. Such policies can, and do, work.

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9 GOVERNMENT POLICIES TOWARDS SMEs: RECENT TRENDS

Present economic conditions, especially economic stagnation and high unemployment, and dissatisfaction with the results of traditional macroeconomic policies, have rekindled interest in technological change as a primary factor in attaining the economic and social goals of society. Technological aspects of industrial policy are being critically looked at. Similarly, science and technology policy is being re-evaluated in most countries and the requirement is increasingly being felt to attune this policy more to the current needs of society, and hence to divert policies and funds from the large scale and prestigious projects of the fifties and sixties, to projects which can have a more positive impact on present-day economic and social problems.

Government policy towards science and technology is not new. Governments have long since followed policies designed to encourage inventions and innovations on the assumption that technical change will ultimately help improve standards of living. Among the earlier measures to encourage inventive spirit were the Patent Acts; they rewarded inventors for their discoveries. Of a different nature was anti-trust legislation aimed at preserving competition, and thereby the entry of smaller firms with innovative products. These measures date from the nineteenth century and were later followed throughout the industrializing world by a large array of institutional steps to enable industry to make use of developing technology. In the UK, the Department of Scientific and Industrial Research (DSIR), aimed at making science and technology contribute to the benefit of society, was established in 1917. In the Netherlands, following lengthy discussions, the Organization for Applied Scientific Research (TNO) was set up in 1932. Similar organizations were established in many more countries. Innovation policy, which is sometimes considered as a policy for change with innovation as its 'symbol', is of a more recent date. It was the Charpie Report, 'Technological Innovation, its Management and its Environment', commissioned in 1967 by the United States Department of Commerce, which first attempted to define, in detail, the contents of such a policy.

Innovation policy is now being considered as having become a point of convergence between industrial policy and science and technology policy, containing elements of both, but at the same time opening new perspectives and avenues of policy (Rothwell and Zegveld, 1981). Innovation policy makers rather recently have especially concerned themselves with the small industrial firm. In the past this category of firm has been much neglected in many countries. Presently, although much more attention is being paid to the small firm and its role in the innovation process, small firms can still be considered more an object of praise than of understanding. In this chapter, 'Small Firm Policy' is used primarily (though not exclusively) to mean 'Innovation Policy towards SMEs'.

The ways SMEs are being treated in innovation policy differ from country to country. There is, among others, a marked difference between the older industrialized countries like, for example, the German Federal Republic where some 43 per cent of overall employment in production is located in firms with less than 500 employees, and the Netherlands where this percentage is 56, and where the economy is more dominated by a small number of large multinational firms. Differences between the countries of Europe and the US are even greater.

A major difference of approach with respect to innovation policies is the role that governments play in the economy and in industrial development generally. Here two kinds of state intervention with regard to planning and industrial policy can be discerned:

- In some countries state intervention in industry is seen as a major part of a process of indicative planning. This is the case in countries like, for example, France and Italy, where industrial policy is used as an important instrument for economic policy and where the objectives of that policy are formulated within a framework of economic and social development plans, which are indicative for the private sector. Industrial (innovation) policy is then formulated through consultative and co-ordinative procedures and institutions within government and between government and industry.
- In other countries industrial policy is seen as a part of general economic policy, aiming to create a favourable climate for industrial development. Although these countries, like the Netherlands, Denmark and the German Federal Republic, use industrial policy instruments or even sectoral policies, these policies are not formulated within the framework of a National Plan, nor are they used as selective policies in an intensive or systematic way.

The above distinction of the two ways of formulating industrial policy should not be seen as a model to describe two totally different worlds. Often, differences are not as great as they would appear. Still other differences in approaches and potential approaches, with respect to innovative policies, are related to the effectiveness of measures in small open economies versus those enacted in their large (and sometimes, by non-tariff barriers, more protectionist) counterparts.

Also, preferences regarding the various economic goals of political parties in power play an important role. Whereas full employment and equalization of income distribution can be considered as traditional priority issues of socialist–labour parties, conservative parties traditionally place more emphasis on price stability and balance of payments equilibria.

Faced with a difficult and complex social and economic situation, governments of the industrialized countries are attempting to devise policies to master inflation and balance of payments disequilibria, in addition to taking measures to facilitate the structural adaptation of their productive systems through innovation policies. Policies towards SMEs are important means to this end.

In this chapter a condensed overview is given of government measures and their trends towards improving the innovative performance of SMEs in the countries of the European Community, Canada, the US and Japan. For the sake of clarity these measures towards SMEs have been divided into the following categories:

General

The role and organization of government

Financial

Tax incentives
Development credits
Venture capital

Technical

Patents and licensing system
Advisory systems and technological information systems
Government-supported laboratories and collaborative research centres
Support for selected technologies

Market

Public sector procurement

Management

Management training

In discussing the above categories of measures, it should be borne in mind that innovation is not a well-defined concept. To some, only major technical breakthroughs with great economic impact are true innovations. Others use the term more loosely to describe changes in technique, organization, marketing, distribution and attitude. Here we adhere to the rather broad definition of Christopher Freeman of the Science Policy Research Unit of the University of Sussex: 'the process of innovation is the first commercial introduction of new techniques; inventions which are introduced into the regular system of production and provision of services are technical innovations.'

From a policy point of view, it is of great importance that sufficient attention should be given to the not so spectacular kind of innovation that determines to a large extent the competitiveness of industry at large, namely the regular, incremental improvement and updating of the product line and increases in productivity. There are often dramatic differences in productivity between firms in the same industry (Salter, 1960) and productivity improvement can be as important to international competitiveness as high technology. Product and process innovations are both important, and for the sake of avoiding unnecessary complexity, this distinction is not emphasized here.

Given the fuzziness of the concept of innovation and the limitations to be taken into account, we have in general not attempted to subject the relationship to innovation of the various measures established by governments to too close scrutiny. We have acted similarly with respect to stated objectives with regard to the support of small industrial firms. In other words, we have adopted a rather loose interpretation of what constitutes small firm policy, especially innovation policy. Prakke (1975) has developed a model of the innovation process for the explicit purpose of evaluating the impact of policy measures on small industrial firms. Highly abbreviated, this model states that the three factors necessary for innovation are information about technical feasibility (technical information), information about demand for a new product or process (demand information) and, finally, investment funds. It might be agreed that although the simplicity of this model is great (for instance 'good management' is often cited as a significant factor that should not be left out, but internal management is not normally directly amenable to governmental policy manipulation), it is a useful framework for our further discussions.

One of the reasons often claimed for the success of the large modern corporation is that it is usually amply provided with each of the three factors mentioned above, and that bringing them together for innovation is 'merely' an organizational and managerial problem. Small firms, however, are very often lacking in one, two or sometimes all three, of these factors, as well as in management capability. The role of government, then, is to facilitate the provision of these factors to small firms as they are needed. The model implies an evaluation of innovation policy at the level of the firm rather than at the level of a particular innovation instrument.

A number of lessons can be drawn from the model for the evaluation of innovation policy in general. A first lesson is that all three factors are a necessary precondition to innovation, and it is therefore of little use to increase the supply of one factor if either of the two other factors is lacking. For example, it is of little use to provide free technical information or low cost loans to a firm that is insufficiently informed about the demand for new products in its area of business. Similarly, venture capital or low cost loans do not help firms that do not have access to the necessary technical information. One reason why it is so difficult to evaluate policy instruments is that they usually provide only one kind of factor, and their effect therefore depends not only on the way that the factor is provided, but also on the presence, at the place of impact, of the other critical factors, including management capability.

A second lesson pointed to by the model is, given empirical research suggesting that demand pull is more critical to innovation than technology push, that governments should place more emphasis on providing market information and venture capital to small firms. This has indeed been a trend in recent policy.

The above considerations should be kept in mind in the description of the following trends in government policies towards small and medium-sized firms.

1. The role and organization of government

The most explicit policy formulations indicating the role and organization of government to foster small and medium-sized firms are found in the US and in Japan. Both countries have formulated comprehensive legislation to this effect. In the US this legislation took the form of a Small Business Act, dating back to 1953. In Japan the Fundamental Law of Small–Medium Enterprises was passed in 1963. Several amendments and extensions to the Small Business Act in the US have since followed.

For example, an important new departure in 1976 was the establishment of an Officer of Advocacy within the Small Business Administration, serving as a focal point for complaints, criticisms and suggestions concerning the policies of the Small Business Administration, and to counsel small business on problems concerning the relationship between small business and the Federal Government.

Since the US Small Business Act of 1953 can be considered as the starting point for many subsequent actions in several countries, and since it points specifically to the role and organization of government in its relationship with small and medium-sized enterprises, the principle content of the US Small Business Act is summarized below.

We feel that devoting a considerable amount of space to quoting significant extracts from this Act is entirely justified, since it represents such a milestone in the field of government policy towards small firms. Further, it illustrates the faith, at the highest possible level in the US Administration, in the crucial role small firms can play in a dynamic, progressive and healthily competitive economy. This faith is embodied in an Act which provides a strong legal framework for assuring the continuance of a vigorous small firm sector in the US.

The US Small Business Act

The US Small Business Act opens with the policy statement that:

> . . . the essence of the American economic system of private enterprise is free competition. Only through full and free competition can free markets, free entry into business and opportunities for the expression and growth of personal initiative and individual judgment be assured. The preservation and expansion of such competition is basic not only to the economic well-being but to the security of this Nation. *Such security and well-being cannot be realized unless the actual and potential capacity of small business is encouraged and developed. It is the declared policy of the Congress that the Government should aid, counsel, assist, and protect, insofar as is possible, the interest of small-business concerns in order to preserve free competitive enterprise* [authors' emphasis], to insure that a fair proportion of the total purchases and contracts or subcontracts for property and service for the Government (including but not limited to contracts or subcontracts for maintenance, repair, and construction), be placed with small-business enterprises, to insure that a fair proportion of the total sales of Government property be made to such enterprises, and to maintain and strengthen the overall economy of the Nation'.

A definition of small business is given in section 3 of the Small Business Act: 'For the purpose of this Act, a small-business concern shall be deemed to be one which is independently owned and operated and which is not dominant in its field of operation.'

In section 4 of the Small Business Act the creation of a Small Business Administration is announced.

> In order to carry out the policies of this Act there is hereby created an agency under the name 'Small Business Administration' (herein referred to as the Administration), which Administration shall be under the general direction and supervision of the President and shall not be affiliated with or be within any other agency or department of the Federal Government. The principal office of the Administration shall be located in the District of Columbia.
>
> The management of the Administration shall be vested in an Administrator who shall be appointed from civilian life by the President, by and with the advice and consent of the Senate, and who shall be a person of outstanding qualifications known to be familar and sympathetic with small-business needs and problems. The Administrator shall not engage in any other business, vocation or employment than that of serving as Administrator.
>
> There is hereby established in the Treasury a revolving fund, referred to in this section as 'the fund', for the Administration's use in financing the functions performed under the Small Business Investment Act of 1958, including the payment of administrative expenses in connection with such functions.
>
> All repayments of loans and debentures, payments of interest, and other receipt arising out of transactions financed from the fund shall be paid into the fund. As capital thereof, appropriations not to exceed $1,721,000,000 are hereby authorized to be made to the fund which appropriations shall remain available until expended.
>
> There is hereby created the Loan Policy Board of the Small Business Administration, which shall consist of the following members, all ex officio: The Administrator, as Chairman, the Secretary of the Treasury, and the Secretary of Commerce. Either of the said Secretaries may designate an officer of his Department, who has been appointed by the President by and with the advice and consent of the Senate, to act in his stead as a member of the Loan Policy Board with respect to any matter or matters. The Loan Policy Board shall establish general policies, which shall govern the granting and denial of applications for financial assistance by the Administration.

The administrative powers of the Small Business Act are stated in section 5 of the Act:

In the performance of, and with respect to, the functions, powers, and duties vested in him by this Act the Administrator may:

- sue and be sued in any court of record of a State having general jurisdiction, or in any United States district court, and jurisdiction is conferred upon such district court to determine such controversies without regard to the amount in controversy; but no attachment, injunction, garnishment, or other similar process, mesne of final, shall be issued against the Administrator or his property;
- under regulations prescribed by him, assign or sell at public or private sale, or otherwise dispose of for cash or credit, in his discretion and upon such terms and conditions and for such consideration as the Administrator shall determine to be reasonable, any evidence of debt, contract, claim, personal property, or security assigned to or held by him in connection with the payment of loans granted under this Act, and to collect or compromise all obligations assigned to or held by him and all legal or equitable rights accruing to him in connection with the payment of such loans until such time as such obligations may be referred to the Attorney General for suit or collection;
- deal with, complete, renovate, improve, modernize, insure, or rent, or sell for cash or credit upon such terms and conditions and for such considerations as the Administrator shall determine to be reasonable, any real property conveyed to or otherwise acquired by him in connection with the payment of loans granted under this Act;
- pursue to final collection, by way of compromise or otherwise, all claims against third parties assigned to the Administrator in connection with loans made by him. This shall include authority to obtain deficiency judgments or otherwise in the case of mortgages assigned to the Administrator;
- acquire, in any lawful manner, any property whenever deemed necessary or appropriate to the conduct of the activities authorized;
- make such rules and regulations as he deems necessary to carry out the authority vested in him by or pursuant to this Act;
- in addition to any powers, functions, privileges, and immunities otherwise vested in him, take any and all actions, including the procurement of the services of attorneys by contract, determined by him to be necessary or desirable in making, servicing, compromising, modifying, liquidating, or otherwise dealing with or realizing on loans made under the provisions of this Act.

Section 7 is devoted to the power to make business loans:

The Administration is empowered to make loans to enable small-business concerns to finance plant construction, conversion, or expansion, including the acquisition of land, or to finance the acquisition of equipment, facilities, machinery, supplies, or materials; or to supply such concerns with working capital to be used in the manufacture of articles, equipment, supplies, or materials for war, defense, or civilian production or as may be necessary to insure a well-balanced national economy; and such loans may be made or effected either directly or in co-operation with banks or other lending institutions through agreements to participate on an immediate or deferred basis.

Section 8 of the Small Business Act deals with the issue of contracts:

It shall be the duty of the Administration and it is hereby empowered, whenever it determines such action is necessary:

- to enter into contracts with the United States Government and any department, agency, or officer thereof having procurement powers obligating the Administration to furnish articles, equipment, supplies, or materials to the Government. In any case in which the Administration certifies to any officer of the Government having procurement powers that the Administration is competent to perform any specific Government procurement contract to be let by any such officer, such officer shall be authorized in his discretion to let such procurement contract to the Administration upon such terms and conditions as may be agreed upon between the Administration and the procurement officer; and
- to arrange for the performance of such contracts by negotiating or otherwise letting subcontracts to small-business concerns or others for the manufacture, supply, or assembly of such articles, equipment, supplies, or materials, or parts thereof, or servicing or processing in connection therewith, or such management services as may be necessary to enable the Administration to perform such contracts.
- It shall also be the duty of the Administration and it is hereby empowered, whenever it determines such action is necessary:
- to provide technical and managerial aids to small-business concerns, by advising and counselling on matters in connection with Government procurement and property disposal and on policies, principles, and practices of good management, including but not limited to cost accounting, methods of financing, business insurance, accident control, wage incentives, and methods engineering, by cooperating and

advising with voluntary business, professional, educational, and other nonprofit organizations, associations, and institutions and with other Federal and State agencies by maintaining a clearinghouse for information concerning the managing, financing, and operation of small-business enterprises, by disseminating such information, and by such other activities as are deemed appropriate by the Administration;

- to make a complete inventory of all productive facilities of small-business concerns or to arrange for such inventory to be made by any other governmental agency which has the facilities. In making any such inventory, the appropriate agencies in the several States may be requested to furnish an inventory of the productive facilities of small-business concerns in each respective State if such an inventory is available or in prospect;
- to coordinate and to ascertain the means by which the productive capacity of small-business concerns can be most effectively utilized;
- to consult and cooperate with officers of the Government having procurement or property disposal powers, in order to utilize the potential productive capacity of plants operated by small-business concerns;
- to obtain information as to methods and practices which Government prime contractors utilize in letting subcontracts and to take action to encourage the letting of subcontracts by prime contractors to small-business concerns at prices and on conditions and terms which are fair and equitable;
- to determine within any industry the concerns, firms, persons, corporations, partnerships, cooperatives, or other business enterprises, which are to be designated 'small-business concerns' for the purpose of effectuating the provisions of this Act. To carry out this purpose the Administrator, when requested to do so, shall issue in response to each such request an appropriate certificate certifying an individual concern as a 'small-business concern' in accordance with the criteria expressed in this Act. Any such certificate shall be subject to revocation when the concern covered thereby ceases to be a 'small-business concern'. Offices of the Governing having procurement or lending powers, or engaging in the disposal of Federal property or allocating materials or supplies, or promulgating regulations affecting the distribution of materials or supplies, shall accept as conclusive the Administration's determination as to which enterprises are to be designated 'small-business concerns', as authorized and directed under this paragraph;

- to certify to Government procurement officers, and officers engaged in the sale and disposal of Federal property, with respect to the competency, as to capacity and credit, of any small-business concern or group of such concerns to perform a specific Government contract. In any case in which a small-business concern or group of such concerns has been certified by or under the authority of the Administration to be a competent Government contractor with respect to capacity and credit as to a specific Government contract, the officers of the Government having procurement or property disposal powers are directed to accept such certification as conclusive, and are authorized to let such Government contract to such concern or group of concerns without requiring it to meet any other requirement with respect to capacity and credit;
- to obtain from any Federal department, establishment, or agency engaged in procurement or in the financing of procurement or production, such reports concerning the letting of contracts and subcontracts and the making of loans to business concerns as it may deem pertinent in carrying out its functions under this Act;
- to obtain from any Federal department, establishment, or agency engaged in the disposal of Federal property such reports concerning the solicitation of bids, time of sale, or otherwise as it may deem pertinent in carrying out its functions under this Act;
- to obtain from suppliers of materials information pertaining to the method of filling orders and the bases of allocating their supply, whenever it appears that any small business is unable to obtain materials from its normal sources;
- to make studies and recommendations to the appropriate Federal agencies to insure that a fair proportion of the total purchases and contracts for property and services for the Government be placed with small-business enterprises, to insure that a fair proportion of Government contracts for research and development be placed with small-business concerns, to insure that a fair proportion of the total sales of Government property be made to small-business concerns, and to insure a fair and equitable share of materials, supplies, and equipment to small-business concerns;
- to consult and cooperate with all Government agencies for the purpose of insuring that small-business concerns shall receive fair and reasonable treatment from such agencies;
- to establish such small business advisory boards and committees truly representative of small business as may be necessary to achieve the purposes of this Act.

- The Administration shall from time to time make studies of matters materially affecting the competitive strength of small business, and of the effect on small business of Federal laws, programs, and regulations, and shall make recommendations to the appropriate Federal agency or agencies for the adjustment of such programs and regulations to the needs of small business;
- within ninety days after the effective date of this subsection the Administrator, the Secretary of Defence, and the Administrator of General Services shall cooperatively develop a small business subcontracting program which shall contain such provisions as may be appropriate to enable business concerns to be considered fairly as subcontractors and suppliers to contractors performing work or rendering services as prime contractors or subcontractors under Government procurement contracts; insure that such prime contractors and subcontractors will consult through the appropriate procuring agency with the Administration when requested by the Administration; and enable the Administration to obtain from any Government procurement agency such available or reasonably obtainable information and records concerning subcontracting by its prime contractors and their subcontractors as the Administration may deem necessary.

Every contract for property or services (including but not limited to contracts for research and development, maintenance, repair and construction, but excluding contracts to be performed entirely outside of the United States or its territories) in excess of $1,000,000 made by a Government department or agency, which in the opinion of the procuring agency offers substantial subcontracting possibilities, shall require the contractor to conform to the small-business subcontracting program promulgated under this subsection, and to insert in all subcontracts and purchase orders in excess of $500,000 which offer substantial possibilities for further subcontracting a provision requiring the subcontractor or supplier to conform to such small business subcontracting programs.

The role of the Small Business Administration towards R & D is described in section 9 of the Small Business Act:

Research and development are major factors in the growth and progress of industry and the national economy. The expense of carrying on research and development programs is beyond the means of many small-business concerns, and such concerns are handicapped in obtaining the benefits of research and development programs conducted at

Government expense. These small-business concerns are thereby placed at a competitive disadvantage. This weakens the competitive free enterprise system and prevents the orderly development of the national economy. It is the policy of the Congress that assistance be given to small-business concerns to enable them to undertake and to obtain the benefits of research and development in order to maintain and strengthen the competitive free enterprise system and the national economy.

It shall be the duty of the Administration, and it is hereby empowered:

1. to assist small-business concerns to obtain Government contracts for research and development
2. to assist small-business concerns to obtain the benefits of research and development performed under Government contracts or at Government expense; and
3. to provide technical assistance to small business concerns to accomplish the purpose of this section.

The Administration is authorized to consult and cooperate with all Government agencies and to make studies and recommendations to such agencies, and such agencies are authorized and directed to cooperate with the Administration in order to carry out and to accomplish the purpose of this section.

The Administrator is authorized to consult with representatives of small-business concerns with a view to assisting and encouraging such firms to undertake joint programs for research and development carried out through such corporate or other mechanism as may be most appropriate for the purpose. Such joint programs may, among other things, include the following purposes:

a. to construct, acquire or establish laboratories and other facilities for the conduct of research;
b. to undertake and utilize applied research;
c. to collect research information related to a particular industry and disseminate it to participating members;
d. to conduct applied research on a protected, proprietary, and contractual basis with member or nonmember firms, Government agencies, and others;
e. to prosecute applications for patents and render patent services for participating members; and
f. to negotiate and grant licenses under patents held under the joint programs and to establish corporations designed to exploit particular patents obtained by it.

Section 10 deals with the reporting of the operation of the Small Business Administration.

The Administration shall make a report on December 31 of each year of operations under this Act to the President, the President of the Senate, and the Speaker of the House of Representatives. Such report shall include the names of the business concerns to whom contracts are let and for whom financing is arranged by the Administration together with the amounts involved.

The Administration shall make a report to the President, the President of the Senate, and the Speaker of the House of Representatives, to the Senate Select Committee on Small Business, and to the House Select Committee To Conduct a Study and Investigation of the Problems of Small Business, on December 31 of each year, showing as accurately as possible for each such period the amount of funds appropriated to it that it has expended in the conduct of each of its principal activities such as lending, procurement, contracting, and providing technical and managerial aids.

The Attorney General is directed to make, or direct the Federal Trade Commission to make for him, surveys of any activity of the Government which may affect small business, for the purpose of determining any factors which may tend to eliminate competition, create or strengthen monopolies, promote undue concentration of economic power, or otherwise injure small business.

The Attorney General shall submit to the Congress and the President, at such times as he deems desirable, but not less than once every year, reports setting forth the results of such surveys and including such recommendations as he may deem desirable.

For the purpose of aiding in carrying out the national policy to insure that a fair proportion of the total purchases and contracts for property and services for the Government be placed with small-business enterprises, and to maintain and strengthen the overall economy of the Nation, the Department of Defense shall make a monthly report to the President, the President of the Senate, and the Speaker of the House of Representatives not less than forty-five days after the close of the month, showing the amount of funds appropriated to the Department of Defense, which have been expended, obligated, or contracted to be spent with small-business concerns and the amount of such funds expended, obligated, or contracted to be spent with firms other than small business in the same fields of operation; and such monthly reports shall show separately the funds expended, obligated or contracted to be spent for basic and applied scientific research and development.

Section 12 deals with the transfer of Small Business functions:

> The President may transfer to the Administration any functions, powers and duties of any department or agency which relate primarily to small-business problems. In connection with any such transfer, the President may provide for appropriate transfers of records, property, necessary personnel, and unexpended balances of appropriations and other funds available to the department or agency from which the transfer is made.

Thus, we see from the above, the rather detailed legal framework in the US for protecting the welfare of SMEs. We believe that this protection, and advancement of the interests of small firms in the US has made an important contribution to the dynamism and vigour of the US economy during the post-war era.

2. Tax incentives for R & D

None of the countries investigated has reported tax treatment of current expenditure on R & D more favourably than for other current expenditure, although Canada, in the past, has allowed more than 100 per cent write-offs of current R & D expenditures. In *the Netherlands* a write-off of more than 100 per cent is being considered, and in the US, from October 1981, a 125 per cent write-off will be operational. What follows, therefore, concerns only countries which reported special treatment of capital expenditure on R & D.

In 1978 the *Belgian* parliament approved legislation on economic reorientation, in which an article provides exemption of tax on profits up to 15 per cent of the value of complementary investments in Belgium during 1979 and 1980. In order to support scientific research it is stipulated that to the extent that the investments are employed for scientific research, the value of the complementary investments, which are proportionally determined, will be raised by 50 per cent for the calculation of the exempted amount.

In *Denmark* legislation includes that with the permission of the tax authorities, the initial innovation expenditures in the period prior to commercialization, and other than those in R & D, may be written off in the first year of commercialization. This would seem to have an effect similar to that of extended loss-carry-forward provisions.

In the *German Federal Republic* the special depreciation allowance for capital R & D investment was terminated in 1970 and replaced by the R & D investment grant act (F & E – Investitionszulagengesetz), thus allowing SMEs to benefit from the incentive independently of their particular tax situation. This legislation was revised and extended in 1978 and now provides a 8.75 per cent tax-free investment subsidy which is available for all investments in machinery and buildings primarily or partially used for R & D activities. The law includes capitalized intangible assets (e.g. patents, licences) up to an amount of DM500,000 per year. In order to meet specifically the needs of SMEs, the investment grant for the first DM500,000 of R & D investment amounts to 20 per cent.

In the West Berlin area a higher investment grant is being provided; 10 per cent for investments in buildings primarily used for R & D and 40 per cent for machinery solely used for R & D purposes. These measures, of course, are not tax incentives in the strict sense, but have the character of a general subsidy for R & D capital expenditure.

A quasi-tax R & D manpower grant programme was introduced in the Federal German Republic in 1979 providing grants to all SMEs (less than 1,000 employees or DM150 million sales per year) on the basis of their expenditure for employees engaged in R & D activities. The programme provides a 40 per cent subsidy on the first DM300,000 spent on the wages for R & D personnel, and 25 per cent for further personnel expenditure. The maximum grant is DM400,000 per year per company.

A subsidy of 30 per cent is given in the German Federal Republic on contract research expenditure up to an amount of DM400,000 per company per year (size: not more than DM200 million sales per year). This contract research may be carried out by any available external research facility, including other companies, provided there is no connection with the company submitting the request. The rationale behind the programme is to offer R & D support to firms not large enough for full-scale in-house R & D departments. The scheme is administered by the AIF (Confederation of Industrial Research Associations).

In *France* 50 per cent of the cost of buildings for scientific research may be written off in the first year, with the remainder amortized over the normal useful life. Exceptional deductions are available to firms subscribing to the capital of 'research' or 'innovation investment' companies, where a deduction from taxable income of 50 per cent of the cost of shares purchased is allowed. Tax-allowable losses may be written off uniformly over a five year period. Finally, royalties remain tax-free as long as they are reinvested within three years.

In the *United Kingdom* most of the expenditure on R & D qualifies for normal tax deduction. Revenue expenditure on R & D – wages, materials and energy costs – are deductible in computing trading profits. Capital expenditure on plant and machinery for R & D have a 100 per cent allowance in the first year, which is set against taxable profits or added to losses. There are special allowances for expenditure on 'scientific research' related to trade. These allowances count for 100 per cent and are set against taxable profits or added to losses. Also expenditures on patent rights qualify for a special tax allowances. The costs of acquiring patent rights may be written off in seventeen years or in the remaining lifetime of the patent. Royalty payments for the use of patents are deductible in the normal way. Finally, in the UK, the government has recently proposed legislation to provide tax relief to individuals for investment in new firm start-ups to a maximum of £10,000 per individual firm.

In *Japan* a 50 per cent tax credit is given for R & D expenses, including the cost of facilities except land. For SMEs a 20 per cent first year accelerated depreciation of the value of all kinds of new equipment is allowed but, as for larger enterprises, this allowance only applies to certain types of designated machinery and equipment. Special tax concessions relate to approved business mergers under the SMEs Modernization and Structural Improvement Scheme.

In *Canada*, the federal tax rate on the first $150,000 of annual income of Canadian-controlled private businesses is 20 per cent as compared to 46 per cent on income in excess of this amount.

3. Development credits

Belgium

The law on economic expansion in Belgium offers the possibility for repayable loans without interest in order to stimulate the use of external consultants. The loan is provided for the cost of hiring consultants and its application is limited to profit-raising promotional activities like innovation and technology transfer; 75 per cent of actual cost is covered by the loan; it has to be repaid after three years.

Aid to the introduction of prototypes, new products and new processes

The Belgian government offers loans within interest to encourage technological innovation. If the programme is successful repayment is required. Usually the loan covers no more than 50 per cent of the provisional budget, but for SMEs the percentage can be increased to 60 per cent. If the development is judged to be of particular importance to the economy and the prospects are good, the loan can be raised to 80 per cent. Before a request is met the programme has to be investigated by the Ministry of Economic Affairs. The results of this investigation are reported to the Commission of Advice for Financing Industrial Research in which representatives of several Departments and of the Federation of Belgian enterprises are represented. The final decision is made by the Minister of Economic Affairs.

Interest subsidy for R & D loans

The Belgian State may subsidize part of the interest which firms pay on loans for R & D from private banks. In the case of self-financing, a premium for capital expenditures may be provided. This measure also affects the acquisition of technology. The amount and the duration of this subsidy depend on the anticipated benefits of the proposed investments to the economy and to regional development.

The 'Institute for Encouragement of Scientific Research in Industry and Agriculture' (*IWONL or IRSIA*)

This Institute was established shortly after World War II; it is a public institute aimed at stimulating scientific and technical research by providing grants. Funds are derived from the Ministry of Agriculture and the Ministry of Economic Affairs. The industrial section of IWONL or IRSIA covers all sectors of industrial research except nuclear. Subsidies may not normally exceed 50 per cent of the research costs, but in exceptional cases subsides may well cover 80 per cent of the costs. Some two-thirds of the projects stem from private companies, one-third are obtained from collective industrial research centres. There are four categories of projects:

- projects with a high technological level and high added value; e.g. in electronics, automation and pharmaceuticals, and projects with high research investments which show promise internationally,
- projects concerning competitive production methods in rather conventional sectors of industry,
- projects to enable industries to work out more scientific approaches to production processes,
- projects with a public interest like the recycling of waste material and the industrialization of the construction sector.

Denmark

The Industrial Research and Development Fund was established in 1970 as an instrument of Danish innovation policy. The activities of the Fund to stimulate industrial R & D are:

- the granting of loans and/or subsidies;
- contracting with respect to the development of new products, materials or production methods;
- investment in shares in Danish enterprises depending on R & D;
- dissemination of research data.

Loans for the financing of product development can amount to up to 70 per cent of the costs. It is a condition that the product has a high degree of novelty. In case of a commercial failure the fund covers 50 per cent of the development costs.

Within the framework of the Government Act concerning subsidies for product development, the secretary of the Council of Technology can render grants for product development amounting to 40 per cent of development costs. This grant, which is taxable, is awarded for the improvement of products already developed. The annual budget is about DKr50 million.

Federal German Republic

Programme for initial innovations (1972) (Erstinnovationsprogramm)

This programme, funded by the German Ministry of Economic Affairs, offers conditional grants of up to 50 per cent of R & D and pre-production costs for projects of particular importance to the economy which, without public financial support, would either not be undertaken, or would progress at a much slower pace because of the high financial and technical risks involved. Although, in principle, companies of all size may apply for funds, by stressing the risk factor, this measure aims mainly at SMEs. The grant has to be repaid if the project proves commercially successful.

Programme of Subsidized Contract Research between SMEs and the Institutes of the Frauhofer-Gesellschaft (FhG)

Since 1976 the Federal Ministry for Research and Technology (BMFT) has allocated DM2.5 million a year to the FhG for the specific purpose of obtaining research contracts from smaller firms by funding between 40 per cent and 60 per cent of the actual cost billed to these firms by FhG. The specific purposes of this measure are:

(a) support of R & D projects in SMEs;
(b) improvement of contacts between SMEs and the technological infrastructure.

The FhG institutes are expected to play an *active* role in obtaining contracts. The measure is expected to increase FhG's awareness of, and interest in, the problems of SMEs. It is being implemented on an experimental basis and is expected to be in operation for a number of years.

European Recovery Programme – Sondervermögen

The ERP funds, administered by the Ministry of Economic Affairs, offer long-term, low interest loans to SMEs. Specific attention is paid to improving the regional structure and to setting up new firms.

The Programme for development and research in Berlin industry

This Programme ('Programm zur Förderung der Entwicklung und damit zusammenhängender Forschung in der Berliner Industrie') offers grants and loans to industry and small and medium-sized firms in particular. Three forms of support exist:

- In the case of at least two-thirds participation by the firm, the money is granted outright.
- In the case of one-half participation there is a limited repayment.
- In the case of one-third participation the total of the support has to be repaid.

Although the programme is open to all industrial branches, because of the structure of West Berlin industry, 80 per cent of the funds have been awarded to the electronic, mechanical, optical, steel, mechanical engineering and transport industries.

France

Actions Concertées, created in 1959, aims at stimulating co-operative national research efforts in public laboratories, collective industrial research centres, private research centres with research oriented firms. The purpose is not to contribute to regular funding, but to start *new* areas of research. The AC are mainly used in fields of fundamental and applied research. The government grants cover 50 per cent to 75 per cent of the costs of the projects. If the project is successful, it can be continued by further development aid. Since 1970 the AC have been complemented by 'Actions Complémentaires Coordinées' (ACC) to facilitate start-up programmes by reducing the administrative time lag. The ACC also handle stages of development where normal procedures are no longer appropriate.

Pre-development Aid, created in 1969, promotes industrial use of research results of the Collective Research Centres and the Engineering Schools. The grants cover 50 per cent of the costs of feasibility studies. The research centres have to be linked to one or more firms which are prepared to develop and market the results. Most of the users are small and medium-sized firms, although the direct beneficiaries are Collective Research Centres.

The Aid to Development was created in 1976. The objectives are:

- the development of prototypes and pilot-plants;
- stimulation of French firms to invest in risky development projects,
- reduction of the risk of development projects for firms in cases where the risks would be too large for the firm itself;
- support of development projects which promise substantial external benefits but which cannot be financed by the firm;
- support of French national firms capable of competing in world markets.

This instrument funds 50 per cent of the cost of the project. Repayment has to be made when the project proves commercially successful. The main industrial sectors affected are: metallurgy, mechanical engineering, electrical engineering, electronics, informatics, chemicals and textiles. The principal beneficiaries are large firms. However, during recent years efforts to promote the use of this measure have succeeded in increasing the number of applications from smaller firms.

The General Interest Programme Aid, 'Soutien aux Programmes d'Intérêt Général', is an instrument for the financial support of technical research carried out in Collective Research Centres, CNRS laboratories and Engineering Schools. This instrument has been established in view of the general interest in the fields of energy conservation, raw materials, world inequalities, the quality of life and working conditions. The results are intended to be disseminated in industry.

The Medium Term Innovation Aid Scheme of 1978 is aimed at financing the expenditure of the commercial and industrial launching of new processes and products. It allows innovative firms to obtain medium-term loans from their local banks with the guarantee of the 'Caisse Nationale des Marchés de l'Etat'. The 'Caisse' benefits from a guarantee fund provided by the Ministry of Industry. Compared with the previous measure, 'lettre d'agrément d'innovation' – initiated in 1971 – the Medium Term innovation measure offers as improvements longer credit terms (ten years) and wider criteria aimed at taking into account all the needs of the firms involved with the innovation. The measure is managed by the Ministry of Industry and its operation is decentralized for loans lower than F500,000.

Ireland

Support for the engagement of consultants

The Department of Industry and Commerce operates a Technical Assistance Grants Scheme which covers 33 per cent of the cost of the engagement of consultants. The Department of Local Government offers the same grants to firms in the building industry. The Department of Agriculture and Fisheries offers these grants to the food industry.

The Industrial Development Authority (IDA)

In addition to the programme to attract (small) industries, the IDA offers a number of measures directly related to innovation, namely;

- The Product and Process Development Scheme offering grants for expenditure up to a maximum of £50,000 for the development of new products and processes. The maximum grant is 50 per cent or £25,000.
- Establishment of Research Centres. The IDA offers non-repayable grants up to 35 per cent of the cost of fixed assets of new industrial research facilities at the Research Park at Naas. These facilities concern the establishment of research centres of not less than 10,000 sq.ft. (about 900 m^2) in the Park.
- The Industrial Research and Development Activities Scheme: This provides for the establishment of R & D facilities in the industrial sector. The grants (between 25 per cent and 35 per cent, depending on location) are available for cost of development, buildings, services, plant and equipment.
- Shannon Free Airport, Development Company Ltd: Shannon Development offers grants up to 35 per cent of the costs for re-equipment and supports the development of indigenous small industries in the mid-west region.

The Irish Export Board offers grants of 50 per cent (between £200 and £2,000) of the costs for engaging designers. There are also grants for marketing research in overseas markets and grants for the indentification and selection for development of products new to the firm. Grants in both instances may amount to up to 50 per cent of the costs.

Finally, the Industrial Development Division (Gaeltarra Eireann) is a semi-State owned regional development company responsible, through its industry development division, for the economic development of the Gaeltacht. It offers, in the context of the Gaeltacht Industries Programme, grants for Research and Development.

Italy

Since 1968 the Fund for Applied Research (Fondo per la Ricerca Applicata, FRA) has been the main government instrument for the promotion of industrial research. The fund is managed by IMI (Istituto Mobiliare Italiano), an industrial credit institution of which the State controlled Casa Depositi e Prestiti is the major shareholder. IMI's main business is the medium and long-term financing of industrial activities on a commercial basis.

As to the application of the Fund, there are several formulas:

(a) Loans at low rate of interest (about 70 per cent of total).

(b) Loans for which repayment is related to (technical) success (about 20 per cent of total). In the case of failure, the firm can either pay back and retain the R & D results, or not pay back and return the results. In the latter case the firm may not use the results for a period of ten years. In practice, the firms have usually chosen to keep the results and pay back the loan.

(c) The provision of venture capital for research firms.

A small part (25 per cent) of the FRA funds have been given as outright grants. Of the FRA funds a minimum of 20 per cent is earmarked for SMEs. The present percentage is close to 30.

The Netherlands

Development Credits, instituted in 1953, are provided by the government to firms unable to develop certain inventions without governmental financial support. Credits can amount to up to 70 per cent of the total costs of the development phase. After that phase the firms should be able to finance the further development of the project without governmental aid. Repayment is required with relatively low interest (5 per cent) when the project is commercially successful.

TNO Contract Credits are granted to smaller firms with insufficient R & D capacity. The R & D has to be carried out by TNO. The maximum credit is Dfl.250,000. This instrument is being implemented on an experimental basis.

Subsidies for expenditure on contract research and development (1979)

A subsidy of 30 per cent is given on contract research and development expenditures up to an amount of Dfl.30,000 per company per year (size: not more than 200 employees per company). This contract R & D may be carried out by any available external research and development facility (including other companies) provided it is not connected to the company submitting the request. The rationale behind this experimental programme is to offer R & D support to small firms without full-scale in-house R & D facilities.

United Kingdom

The Department of Industry has established nine Requirement Boards for special industrial or technological areas. These areas are: Ship and Marine Technology; Chemicals and Minerals; Engineering Materials; Computer Systems and Electronics; Mechanical Engineering and Machine Tools; Metrology and Standards; Electrical Technology; Garments and Allied Industries; Chief Scientists' Board (which covers industries or technologies excluded by other boards). All major sectors of the civil manufacturing industry are included, except aerospace. The members of these boards are drawn from industry, universities and the government. Their objective is to improve the technological base of the industry by helping fund R & D projects carried out by companies and research organizations, including research associations. In addition the Boards approve the work done in government research establishments.

Collaborative Development Contracts are aimed at risk-sharing between the government and contractors. The government usually provides 50 per cent of the cost and receives levies on commercial sales if the development is successful. Most of these contracts do not cover costs beyond the development of a prototype. Under the Product and Process Development Scheme (PPDS) of July 1977, the stages between prototype and full commercial production will receive more attention.

The Pre-production Order Assistance is a part of the PPDS. It implies the possibility of government purchases of equipment from a manufacturer. The Department of Industry buys the equipment at its prototype stage and makes a separate arrangement with the user of the equipment. Users do not pay rent and have an option to return or buy the equipment after a specified period. The objective of this measure is to encourage early production at the prototype stage of untried equipment.

The Product and Process Development Scheme (PPDS) regulates the assistance available to manufacturing industry. The support for R & D in companies comes under the Science and Technology Act of 1965. So far over £20 million has been made available. The financial assistance to firms is given for costs of product/process development from the design stage up to commercial production. The sectors affected by this measure are mechanical and electrical engineering. The applications from firms are considered in the industrial context and in the light of the aims of the prevailing national industrial strategy.

There are two types of assistance:

(a) a grant of up to 25 per cent of qualifying costs;

(b) a shared cost contract for government contribution up to 50 per cent of the qualifying costs, with a levy on sales.

The Software Products Scheme was created in January 1973 and provides support for half the cost of development and the first year's operating expenses in the Computer Service Industry.

The programme for encouraging collaboration between small firms began in April 1976. This aid is aimed at encouraging the provision of common services of management and technical assistance. Under this scheme the government contributes up to half of the cost of studies (with a £5,000 limit) to examine the feasibility of collaboration.

The Microelectronics Industry Support Scheme was set up by the Department of Industry to retain and make viable a UK capability in the development, production and marketing of custom-designed special semi-conductor integrated circuits for specific user applications. It is intended to support projects through to the pre-production stage, until a product acceptable to the consumer is available. The development costs of a project are shared equally between the Department and the company undertaking that particular product development. The Microelectronics Industry Support Programme offers assistance for research, design, development and production launch of new products and processes in the area of silicon integrated circuits, hybrid microelectronic specialized discrete semi-conductors and related components.

In parallel to this scheme the Microprocessor Application Project (MAP) was established. The aim of MAP is to speed up the use of microprocessors in industry. It has a strong 'awareness and training' component and a consultancy support scheme to assist SMEs in particular in producing feasibility studies on the adoption of microprocessors. Finally there is development aid for projects involved in the utilization of microprocessors.

Japan

The three principal Japanese Government affiliated financial institutions for manufacturing industry SMEs are the small Business Finance Corporation, the People's Finance Corporation and the Central Bank for Commercial and Industrial Co-operatives. There also exist a number of private financial institutions specifically for SMEs, such as the Mutual Loan and Saving Bank, the Credit Association and the Credit Co-operatives.

Finally, Table 9.1 summarizes government subsidies to SMEs in nineteen advanced market economies. This table is taken from a recent draft report on innovation and SMEs by the OECD (1981).

4. Venture capital

The *German* Venture Capital Bank (Deutsche Wagnisfinanzierungsgesellschaft WFG) was founded in 1975, following an initiative from the BMFT. The main task of this bank is to provide equity capital for high risk technological innovation in SMEs. It also takes part in innovative enterprises and provides management assistance. The partners of the WFG are smaller firms with a maximum turnover of DM100 million, or about 2,000 employees. The participation per project is between DM0.4 million and DM2 million. The Federal Government guarantees the reimbursement of 75 per cent of the WFG's losses for its first fifteen years of operation.

In *France* ANVAR, the 'Agence Nationale pour la Valorisation de la Recherche', was constituted in 1968 to assist in particular public laboratories in licensing patents. ANVAR offers some venture capital.

The French 'Société pour le Financement de l'Innovation' (SOFINNOVA) instituted in 1972, provides venture capital to new enterprises, based on an innovative project (about 20 per cent of funds) and for the stimulation of innovating in existing firms (about 80 per cent). Most of the funds are awarded to small and medium-sized firms. Batinnova, the 'Société de Financement de l'Innovation, Bâtiments et Travaux Publics', is a part of the SOFINNOVA group and specializes in providing venture capital in the building and construction industry.

Soginnove, the 'Société Générale pour le Financement de l'Innovation', established in 1974, also provides venture capital to SMEs.

In *Ireland*, Fior Teoranta has as its main function to provide finance to firms having difficulty in raising risk capital from normal commercial sources. the IDA and Gaeltarra can, in addition to providing grants, take equity and give loan guarantees to ventures which other institutions would not otherwise service.

Table 9.1 Government subsidies to small and medium firms' R & D activities

Names of schemes (upper limit of public contribution)	Approximate budgets (fiscal year)	Percentage of funds for SMEs (upper size of firms)
Australia		
Commencement grants	–	≅ 100%
Project grants	A$m. 2.5 (76/77)	–
Austria		
Forschungsförderungsfonde der gewerblichen wirtschaft	Asch.m. 314 (78)	–
Belgium		
Aid to prototypes (50–80%)	FBm. 4.5 (77)	15% (500 p)
IRSIA's subsidies (50%)	FBm. 1600 (77)	27% (500 p)
Interest's premium on bank loans for R&D	–	–
Canada		
IRAP (payment of firms' R&D salaries)	C$m. 20 (78/79)	51% (200 p)
Mini IRAP (payment of salaries in outside contractors)	C$m. 0.5 (78/79)	100%
Enterprise Development Program (70%)	C$m. 26 (77/78)	100%
Defence industry productivity progr. subsidies and loans (70%)	C$m. 45 (78/79)	–
Program for industry/ laboratory projects	C$m. 4	33 out 47 beneficiary firms
Denmark		
Product Development support (40%)	DKr.m. 50 (80)	63%
National Agency of Technology's Project support to industry and institutes	≅ DKr.m. 70 (80) m. 30 special appropr. for SMEs	
France		
'Actions concertées'	FFm. 381 (77)	10%
Innovation Aid (Aide au Développement (50%) Aide au Prédéveloppement)	≅ FFm. (319 + 27.5) (77)	(15% + 63%)
Innovation Premium (for contract placed outside)	FFm. 1 (79)	100%
Guarantee on bank loans for innovation (lettre d'agrément)	–	–

Names of schemes (upper limit of public contribution)	Approximate budgets (fiscal year)	Percentage of funds for SMEs (upper size of firms)
Finland		
Ministry of Trade and Industry's subsidies for product development		
– grants	Mk.m. 25 (78)	39% (100 p)
– loans	Mk.m. 21.5 (78)	36% (100 p)
SITRA's loans	Mk.m. 26.4 (78)	38% (100 p)
Regional funds (KERA)	Mk.m. 15.7 (78)	100%
Germany		
Subsidies to cost of R&D personnel (40%)	budgeted DMm. 300 (79)	100% (1,000 p)
Subsidies to R&D contracts placed outside (30%)	budgeted DMm. 8 (78)	100%
Direct promotion of R&D projects: BMFT's technological priorities. BMWI's initial innov. prog. technical dev. in Berlin	estimation: DMm. 150	for SMEs (1,000 p)
Ireland		
IDA grants for R&D facilities (35%) IDA grants for product and process dev.	£Ir.m. 0.62	mostly in SMEs
(IDA grants for new enterprises)	(£Ir.m. 39.4)	
Italy		
IMI's fund for applied research	Lm. 250 (68–77)	28% (300 p)
Japan		
SMEA's technical develop. subsidies	Ym. 995 (79)	100% (300 p)
SBPC's loans for industralization of new techniques	–	–
The Netherlands		
Development credits (70%)	Fl.m. 60 (78)	44%
Increase of dev. credits for SMEs	Fl.m. 2 (80) 3.8 (81)	
(for large firms)	Fl.m. 7.9 (80) 47.3 (81)	
Subsidies for contracted research placed outside (30%)	Fl.m. 2 (budgeted 79)	
Guidance schemes for SMEs' innovation projects	Fl.m. 7.9 (80) 12.6 (81)	
(Assistance to tech. and com. feasibility studies and support to agencies providing advice and know-how)		

Table 9.1 (cont.)

Names of schemes (upper limit of public contribution)	Approximate budgets (fiscal year)	Percentage of funds for SMEs (upper size of firms)
New Zealand		
Projects and commencement grants	–	mostly for SMEs
Norway		
InnovasjonsPlan (NTNF subsidies + Industriefondet) loans (85%)	No.Kr.m. 150	10% (200 p)
Portugal		
Subsidies to prototype and industrialization development (75%)	–	mostly for SMEs
Sweden		
Region funds (RUFO)	S.Kr.m. 322 (78/79)	mostly for SMEs
Switzerland		
Countercyclical program subsidizing R&D contracts placed outside	SF.m. 24	mainly SMEs
United Kingdom		
PPDS's reimbursable subsidies (50%)	–	–
Department of Industry (Requirement Boards and Sponsorship Divisions)	–	–
CASE Awards	–	(100%)
United States		
NSP Small Business Innovation Program	≅ \$m. 0.5 (Progressive extention to other Agencies up to \$m. 150)	100%

In 1975, SME received 7.8 per cent (\$m. 665) of the total government awards for R&D.

Source: OECD (1981), *Government Policies on Stimulating Innovation in Small and Medium-sized Firms* (Draft Commentary), DSTI/SPR/80.20, Paris, June.

The Irish Industrial Credit Company Ltd. has a venture capital scheme. Under this scheme either share or loan capital, and sometimes a combination of the two, can be made available. Loan capital provided under the scheme carries repayment periods of up to fifteen years. Sometimes arrangements can be made to postpone principal repayments for the first three years.

Besides the venture capital provided for research firms by the *Italian* IMI, there are a number of bank-held investment firms (the banks themselves are by law not permitted to participate directly in companies not listed on the stock exchange), which can be said to be regularly or intermittently involved with venture capital type operations, i.e. taking equity in unlisted firms.

In *Holland*, Risiko Kapitaal Nederland B.V. is an independent corporation set up by five private banks and the partly State-owned National Investment Bank (NIB). The NPM (Nederlandse Participatie Maatschappij N.V.) is also owned by banks and the NIB, as well as by a number of insurance companies. At the moment these two companies have invested in 110 Dutch firms with an average of funds invested per company of Dfl.140,000. In the period 1975 through 1977, Risk Capital B.V. made eight new investments compared with twenty-one at NPM. Both are looking for minority equity positions involving amounts in excess of Dfl.100,000. Investment of less than Dfl.100,000 are regarded as not justifying the cost of the initial feasibility investigation. The financing of start-up operations is also undertaken by both institutions where the new venture is based on a novel technological development.

In the *UK* the Industrial and Commercial Finance Corporation (ICFC) is 85 per cent owned by private banks and 15 per cent by the Bank of England. The holding company of the ICFC is Finance for Industry Ltd. The minimum and maximum loans of the ICFC are £5,000 and £1 million respectively. The ICFC maintains a network of branch offices. Branch office managers are able to provide a local link and advice. The period of funding is between seven and twenty years.

The Technical Development Capital (TDC) of the UK, created in 1961, specializes in investment in firms involved with high-technology developments, and in investing in start-up situations. The minimum funds are £5,000, and when the maximum is reached ICFC or NRDC can take over (about £500,000). The funding runs from the start-up period into development.

The National Research and Development Corporation (NRDC) has been a source of finance for technological innovation in small firms, despite the fact that this type of aid is a minor part of the total budget of NRDC. The

NRCD supports advanced technologies which are in the public interest. In addition to offering venture capital, NRDC is able to offer technical, patent, information and marketing services as well. There is no specified period of funding or minimum/maximum of funds, but in the case of successful projects funds have to be repaid through royalties.

The National Enterprise Board, established by the last Labour government, has also issued risk capital, on an equity basis, to fund new high-technology based firms, notably through its regional offices. During the late summer of 1981, the NRDC and the NEB were merged to form the British Technology Group. The new BTG will have three divisions. These are Technology Transfer (to deal with R & D and patents), Investment and Operations. The BTG intends to concentrate on three technology areas: information technology and electronics; engineering and robotics; biotechnology. The BTG will also have a special university co-ordinative department to attempt to bridge the gap between academic research and industry.

Other venture capital banks in the United Kingdom are: Charterhouse Development, Gresham Trust, Hambros Banks, Small Business Capital Fund, Hill Samuel Development Finance, National and Commercial Development Bank, Midland Montagu Industrial Finance, Noble Gressart Investments, Citicorp International Capital, European Business Development. These banks are interested in different kinds of clients or sectors; the minimum and maximum funds vary, most minima range from £25,000 to £50,000, while maxima go up to £500,000. The period of funding varies between five and ten years.

In the *US* the Small Business Investment Companies (SBICs) arose out of the Small Business Investment Act which authorized SBA to license, regulate and help finance privately organized and operated SBICs. The rationale behind the act was to provide the opportunity for small firms to obtain long-term capital to finance their growth. Many SBICs are owned by relatively small groups of local investors; the stock of more than twenty SBICs is publicly traded; seventy SBICs are partially or wholly owned by commercial banks; some SBICs are subsidiaries of other corporations.

There are two types of SBIC investment in small firms:

Equity type investments

- Loans with Warrants: in return for a loan, the small business issues warrants enabling the SBIC to purchase common stock in the company, usually at a favourable price, during a specific time period.
- Convertible Debentures: the SBIC lends the small business money and in return receives a debenture. The SBIC can then either accept repayment

of the loan or can convert the debenture into an equivalent amount of common stock.

– Common stock: the SBIC purchases common stock from the small business.

Straight loans

– SBICs can make straight loans which involve no equity features. The interest on straight loans is determined through negotiation between the SBIC and the small business, subject to a legal maximum.

The success of a SBIC is linked to the growth and profitability of the small firms in which it has invested. SBICs, therefore, see it as in their own interest to offer various forms of management assistance to small firms, to assist them to administer properly their projects.

An examplary programme to aid innovation in small firms, and one based on a thorough understanding of the innovation process, seems to be the US National Science Foundation's Small Business Innovation Research Program. The programme forces a certain portion of departmental funds for applied research to go to small contractors who can establish a potential link (in the first phase) and a real link (in the second phase) with venture capitalists or industrial users.

Finally, it is probably true to say that in many countries the paucity of private venture capital – certainly outside the United States – is being increasingly recognized by governments as an important problem. Thus, the inability of private venture capital to close the 'venture capital gap' is forcing more governments to offer public funds. Table 9.2 lists public venture capital schemes currently in operation in seven OECD member countries (OECD, 1981).

5. Patent and licensing systems

Although no detailed documents on patent systems are generally available, it can be said in general that countries such as the Federal Republic of Germany and the Netherlands historically have adopted a policy of making patents difficult to obtain but which result in automatic protection, while other countries such as France have made patents easy to obtain but subject to challenge in the courts at a later date. Countries differ perhaps most importantly in their instruments to encourage the use of the patent system. The European patent has recently been set up; the first European patent applications were presented in June 1978. Recent proposals of the Commission of the European Community on regulations covering licensing agreements have been the subject of lively debate.

Table 9.2 Public Sector Venture Capital

Country		Mechanism	Operational rules	Indicative volume
Canada	Loans	Federal Business Development Bank	Fixed term loans	1972 5,889 loans $282.3 m. 1978 9,908 loans $479 m.
		Enterprise Development Programme	Guarantees up to 90% of loans received from private banks	1979 67 loans $100.7 m.
	Loans guarantee	Small Business Loans Act	Guarantees up to $75,000	1970 1,367 loans $13.2 m. 1976 5,158 loans $82.1 m.
	Equity	Federal Business Development Bank	New programme, flexible rules	1978 69 new investments value $11.7 m.
France	Loans	Caisse Nationale des Marchés de l'Etat	Medium term loan Loan guarantee	1976 FF2.5 m.
		Sociétés de développement régional (15)	Long and medium term loan/ guarantee	
	Equity	Venture capital companies (2 companies, Sofinova, Soginnove)	Variable	Approximately 20 investments totaling some FF15 m./year for the two companies
		Sociétés de développement régionale	up to 35% equity	Less than FF20 m./year
Germany	Loans	Kredit anstalt für Wiederaufbau (KFW)	Long term loans Entrepreneur establishment programme	1978 DM975 m. 1978 DM500 m.
		Länder banks	Long term 'soft' loans	
	Loans guarantee	Länder banks KFW	Guarantees given to SMEs' own banks	
	Equity	Deutsche Wagnisfinanzierungs Gesellschaft	Minimum participation DM400,000	Up to 1978 DM50 m. invested

Netherlands	Loans	Development Credit Scheme (Ministry of Economic Affairs)	15 years, interest at 5% – No start-ups	1971 HFl.15.7 m. 1976 HFl.58 m.
		Industry Guarantee Fund	Usually 20–50% equity (entrepreneur can buy back at pre-determined price)	Has made over 100 investments altogether 1977 12 new investments
		Spearpoint + technologically advanced projects	Up to 50% equity	1977 HFl.43.7 m. on 15 projects
	Equity	Regional Development Funds (WOM, LIOF, GOK)	Up to 100% equity (average 61%)	1978 Total equity stock up Fl.110 m.
Sweden	Loans	State Craft and Industry Loan Fund AFI + ABF	15 year loans, 90% of security offered Premium over commercial rates	1970 512 new loans 1978 1,766 new loans
	Loans guarantee	AB Industrie Kredit (ABI) AB Företags Kredit (ABF) State craft and industry loan	fd.	
	Equity	Företags Kapital AB Swedish Industry	Minority holdings (20–45%)	Low level of activity total holdings about SKr.100 m.
United Kingdom	Loans	Industrial Commercial Finance Corporation (ICFC) Development agencies	15 years fixed interest Minimum £5,000 Concessionary rates 5–10 year life	
	Equity	ICFC National Research Development Corporation National Enterprise Board	Minority equity state Joint ventures about 50% equity – £5,000 minimum Minimum £100,000	1978 £50 m. in 120 companies at about £4.5 m. per annum

Table 9.2 (*continued*)

Country		Mechanism	Operational rules	Indicative volume
United States	Loans	Small Business Administration		1970 8,719 loans $528 m. 1978 27,626 loans $3,300 m.
	plus	Local Development Corporations	Variable	Increasing activity
	Loan guarantee	Economic Development Administration	Loans up to $1 m., guarantees up to 90% of $3 m.	
	Equity	(SBICs)	Variable package of equity + convertible loan stock	1970 1,514 participations $110 m. 1978 2,551 participations $251 m.

Source: OECD (1981), *Government Policies on Stimulating Innovation in Small and Medium-sized Firms* (Draft Commentary), DSTI/SPR/80.20, Paris, June.

From the point of view of SMEs, patents can represent a serious problem. Many have neither the time nor resources to enable them to undertake the often rather complex application procedures. Perhaps more important, few SMEs possess the resources to enable them to fight patent infringements in the courts, especially infringements by large corporations. With these problems in mind, several countries (e.g. Denmark) have established special offices to assist SMEs with patenting.

The *Danish* Patent Directorate's Service Division undertakes various information tasks in relation to invention and to the development of products. There are, for instance, examinations of novelty on the basis of a brief description of the invention, and the newest techniques known from the patent literature within a specified field are identified. The Danish Invention Centre promotes licensing-contracts for inventors and small business.

The Patent Bureau for *German* Research (Patentstelle für die Deutsche Forschung) was founded in 1955 by the Fraunhofer Society and provides consultancy and credits for research workers and independent inventors to patent their work and find industrial sponsors for development. It is planned that SMEs will have more opportunity to make use of the services of the Patentstelle. In particular the patent search service of the Patentstellen for SMEs will be extended.

The Max Planck Society (MPG) owns Garching Instrumente GmbH, whose main tasks are mediation in licensing patents for members of the MPG, prototype development and the sale of high-technology products developed in the MPG institutes.

The German working group on the exploitation of patents (Arbeitsgruppe Patentverwertung, ARPAT) is now establishing a system which informs industry on patents resulting from government-funded projects. It offers information, particularly for smaller companies, on the available patents and also tries to find licensees for promising patents that are not exploited by a company that has received government funds.

The German Big Research Establishment Technology Transfer Offices (Technologieverwertungstellen der Grossforschungszentren) license and sell to private companies patents and R & D results of government-subsidized research, and the German Patent Office (Deutsches Patentamt) offers patent surveys on specified technological areas to all companies independently of whether a patent is applied for. Companies are charged for these investigations which normally are standard procedures of the Patent Office's review and evaluation process.

In *France*, ANVAR, the 'Agence Nationale pour la Valorisation de la Recherche', was constituted in 1968 to assist laboratories, in particular public laboratories, in licensing patents. The aid consists of mediation and financial aid. The French INPI, the 'Institut National de la Propriété Industrielle', also offers information and registration services connected with patents and licences.

In the *UK* the NRCD owns and manages certain patents originating from government and university research, and a small number of patents, about 10 per cent of the whole, arising from private individuals and industry. The NRDC is the oldest and largest organization of its kind.

The *Canadian* Patents and Development Limited (CPDL) is a Crown Corporation responsible for arranging the commercial exploitation of inventions arising from research carried out by government departments, universities and public research institutions. In this capacity, CPDL screens disclosures from its various sources, and arranges to patent those deemed to have commercial potential. CPDL maintains an inventory of such inventions, which are available for licence, and which it advertises to industry by means of trade shows, technical publications and an 'Inventions Catalogue'. The company is assisting the University of Waterloo in the provision of a service to inventors, designed to provide an early assessment of the potential of an invention, along with recommendations as to the need for further development, markets etc. The inventor retains the full rights. A number of these centres will be introduced across Canada over the coming years.

6. Advisory activities and technological information systems

Belgium

The Service for Industrial Promotion, 'Dienst voor Nijverheidsbevordering (DNB.)', has features in common with other European institutes like NRDC and ANVAR. Its objectives are promotion of the development of technological innovations up to their industrial and commercial phase, and the study of possibilities in this field. The service is engaged in the following activities:

- search for innovations and development up to the end-phase of commercialization and industrialization;
- investigation of the possibilities of new products;
- promotion of industrial projects;
- promotion of the industrial and commercial development of patents originating from government-funded research;
- research on matters of concern to industry;
- action to promote the national economy.

Denmark

The Danish Council of Technology, established in 1973, co-ordinates the establishment of the technological service network. The council supports two main activities:

- technological service;
- non-market projects in all fields of technology;

In a wider sense the tasks of the Council are:

- to follow technical and commercial developments in Denmark and abroad and, on this basis, to consider, give advice on, or initiate measures to promote, the development of technology for the benefit of trade and industry and of Danish society in general; to plan and co-ordinate public efforts to support technological service activities; to survey and support technological service activities and control the utilization of the financial support given and to take the initiative towards, and counsel, public authorities and others with regard to matters concerning technological service.

There are two Technological Institutes in Denmark, one in Copenhagen (1906), the other in Aarhus (1942), which consist of twenty-five and twelve specialized divisions respectively. Both institutes provide technical assistance to industry. The most important instruments to provide this support are training courses, a question and answer service, and a dissemination of information and liaison service. Both Technological Institutes have a number of associated regional information centres. There are now five of these connected with the technical institutes, but their number is soon to be increased. The regional centres have a certain local involvement in managing and financing. The centres scan the need for technological services within small and medium-sized enterprises and indicate relevant possibilities for support. Support for solving smaller problems is given by the centres' own consultants.

The Danish Invention Centre, established in 1972, aims at providing legal, technical and general advice to inventors. Most of the beneficiaries are individual inventors and small firms. The centre processes about 1,000 inventions per year. Some 2 per cent reach the new product stage. If the initial searches are positive, there is a sum of about DKr.25,000 available for the development of the subject project. The main activities of the Invention Centre are: advisory and evaluation activities; activities to promote potentially successful inventions (prototype workshop facilities, supervision, etc.); activities to promote licence contracts and activities in the field of technology scouting. Scouts visit universities, colleges, institutes, advanced educational establishments, government enterprises, etc., in an attempt to identify research and development projects that stimulate new products.

The Danish 'Information for Industry' service (DTO), largely a State-supported institute, provides technological information service for manufacturing industry. The main services offered are: liaison service, active information service, and telephone question and answer service. Most of the enterprises taking advantage of this service are small or medium-sized.

The Productivity Council set up by the Danish Ministry of Trade deals with productivity-promotion measures within industry, commerce and trade. The council provides financial support for general information activities on productivity problems, training of consultants, conferences and courses and research projects dealing with productivity problems.

Federal Republic of Germany

The Rationalization Board of German Industry (Rationalisierungskuratorium der Deutschen Wirtschaft, RKW) is a non-profit organization with some 10,000 members from private industry, individuals and public institutions. In addition to a central office, RKW has regional offices in each of the Länder. The annual total budget of RKW is some DM30 m., which is composed of membership dues, income from services rendered and grants from the Federal and Länder governments.

Since 1950 the main tasks of RKW have been:

- encouragement and promotion of efforts to increase industrial efficiency and effectiveness;
- co-ordination, transfer and support for the practical application of rationalization results in the economy and the administration;
- increase of the efficiency specifically of small and medium-sized industrial firms.

The importance of the RKW proceeds more from its broad concept of encouragement than from solely technology transfer.

Technological Advisory Service to SMEs, carried out by the German Rationalization Board (RKW) and the Regional Chambers of Commerce (1977); BMFT, Forschungs- und Technologieberatung: these services are restricted to SMEs. A short inquiry into technological problems and needs of SMEs is carried out without charge. If a company is then interested in an in-depth inquiry into special technological and/or market problems, the relevant advisory agency will suggest and refer to the services of a commercial consultant. These consultancy costs, again, are subsidized by up to 75 per cent according to firm size.

Technology Center Berlin (VDI Technologie-Zentrum): the German Engineers' Association (Verein Deutscher Ingenieure, VDI), administers a central training and management assistance centre in Berlin, specifically tailored to assist SMEs in introducing microelectronics. Sectors to be assisted with the introduction of microelectronics are selected after a study of the relevance of microelectronics to their products and processes and their strategic importance in international competition, trade and regional development. In the case of the watchmaking industry, for example, a working party was established with members from BMFT, Fraunhofer Society, the user industry, the German manufacturers of components, and the Labour Unions. This working party acted as a steering committee for a study on the technology/market development and on company restructuring patterns and social consequences.

Services available under this scheme are: comprehensive advice on industrial applications and the possibilities of diversification; basic technical advice and the provision of know-how; preliminary check on development projects; advice on the availability of public funds and assistance with applications for government aid for development projects connected with the application of semiconductor technologies. There is 50 per cent cost sharing in R & D and innovation projects according to the general BMFT scheme.

Finally, two University Contract Research Liaison Offices have been established as pilot projects in Bochum and at the Technical University of Berlin. Each office is designed to couple the R & D demand of regional companies with university R & D and consulting capabilities and is funded jointly by the Federal and the State governments.

France

Regional policy for innovation: twenty 'Déléguées aux relations industrielle' (DRI) are now working regionally. The objectives of this project, which started in 1972, are as follows:

- to make local university research better known in the region;
- to contribute to the implementation of the results of this research;
- to develop contacts between industry, universities and research centres;
- to contribute to the organization of training courses, to the diffusion of information on jobs available in industry, and to a better knowledge of

industry on the part of researchers and university professors in order to improve their mobility;
- to advise institutions that are interested in knowing the social and economic impact of their research.

The DRI are placed in 'Research Industry Associations' (ADER) and their nomination is approved by the Department of Industry. The creation of specialized technical research centres in the regions, CERMAT (textile mechanics) in Alsace, 'Institut du Lait' in Bretagne, 'Institut de Soudure' (welding) in Lorraine, CEPICA (chemical engineering) in Midi-Pyrénées, are examples of the results of this scheme.

'Ateliers d'innovation' (Innovation workshops): two of these will be set up as an experiment, one in Ruffec (Poitou-Chardetes), the other in Flers (Basse-Normandie). They will provide workshop facilities to SMEs.

Regional Agencies for Scientific and Technical Information (ARIST): these services, established especially for small and medium-sized firms, are to be extended throughout France. Most of them will be managed by the Chambers of Commerce. Some will be placed in other organizational settings; technical centres, universities or engineering schools. Some specialized information services will also be set up on a trial basis within technical centres in the food and agriculture sector.

Industrial Creation Centres: these are places where industry can come and elaborate new products or test new manufacturing processes. They will have, as far as possible, to be set on the existing regional infrastructure: engineering schools, universities, technical schools, etc.

Ireland

The Institute for Industrial Research and Standards (IIRS) is Ireland's largest technical consultancy organization for industry. Originally established in 1946, the Institute now employs about 600 staff and is active in a very wide range of industrial technologies.

The main objectives of IIRS is to assist in the development of industry by making new technology available through the expertise of its staff and through its access to world information sources. A division of the Institute provides 'current awareness' information services as well as access to international data systems. Applied research, which accounts for about a quarter of the Institute's annual budget, is concentrated in Engineering Design and Forest Products. A team of technical liaison advisers maintains contact with companies to determine their needs and to guide them in the use of the Institute's services. A large part of IIRS work is undertaken directly for individual client firms, on contract. This ranges from the development of new products to the performance of routine tests on the composition or quality of materials.

The Netherlands

The Industrial Consulting Service, 'Rijksnijverheidsdienst (RDN)' (1907), offers techno-economic information services for SMEs. The Service offers consultancy services through regional offices and is particularly interested in techno-economic problems of small firms. This service operates under the responsibility of the Ministry of Economic Affairs.

Central Institute for Industrial Development (CIVI) (1955) is an organization providing industry and government with market services, technical services and evaluation capacity.

Finally, the Experimental Project Industrial Innovation was initiated in 1976 and aims at assisting small and medium-sized companies in developing a strategy for innovation. This is done via the process of converting knowledge and ideas into concrete innovations. The project follows two lines; one for new firms and one for existing firms and also aims at encouraging commercial management consulting firms to enter into this type of consultation.

United Kingdom

The tasks of the National Research Development Corporation (NRDC) (1948) are:

- to develop and exploit inventions resulting from publicly financed research;
- to develop and exploit inventions which are not being sufficiently developed and exploited;
- to support research which is likely to lead to inventions;
- to manage property rights in connection with inventions resulting from public research and from other sources if in the public interest.

The NRDC supports industrial development programmes usually on a joint venture basis. Industry usually retains ownership of the products and NRDC receives a levy on sales. The methods of transferring inventions from the NRDC to the private sector are:

- finding an enterprise which will take a development project on its own under licence from the NRDC;

- joint ventures with enterprises, with a system of levies if the project is commercially successful;
- setting up subsidiary enterprises.

The majority of firms receiving NRDC project development aid are small or medium-sized, but most of the funds have been devoted to a few large projects such as computers, hovercrafts and bio-chemistry.

The British Council of Productivity Associations (BCPA) was established in 1952 by employers' organizations and trade unions. The objectives are to improve productivity in the UK. The BCPA is now a federation of forty-one regional associations.

The Computer Aided Production Management Scheme for Small Firms was launched in September 1977 to help small firms to use computer aids for production management in order to improve efficiency. The objective is to relieve companies of some of the risk.

The Design Council Advisory Services offer advisory services to manufacturers in the field of engineering and industrial design. Funds derive partly from the government. Although the Services were originally intended to support smaller firms, large companies have used the service as well.

Industrial Liaison Service Centres have been set up at seventy colleges to stimulate the dissemination of technical knowledge to smaller firms. The scheme started in 1966 and terminated in 1973 when Small Firms Information Centres were set up following the Bolton Committee on Small Firms. Some forty centres still operate independently of government support.

Small Firms Centres (SFCs) provide a free service designed to put small firms in touch with appropriate sources of professional, commercial or official advice to assist with their technical and other problems. Experience has shown that there were problems which were not readily identifiable or that required more detailed or specialist guidance, and so a complementary Small Firms Counselling Service has been set up. Counselling is carried out by experienced businessmen who discuss the difficulties facing owners and managers of small firms and offer advice and guidance aimed at helping clients to produce solutions to their problems. Pilot schemes of Technical Counselling were launched early in 1979 in two regions of the UK.

Finally, The Manufacturing Advisory Service (MAS) was set up in 1977 to provide advice on technology and the use of improved production methods in small and medium-sized firms in the engineering, manufacturing and non-ferrous foundry industries.

7. Government Laboratories and Collective Research Centres

An important component of government support for SMEs (technology supply) is formed by the scientific and technological infrastructure. From the special viewpoint of SMEs, it is the collective industrial research institutes which probably have the most important direct role to play in assisting them with their technical (and other) problems (Rothwell, 1980).

Belgium

In Belgium there exist thirteen industry-specific Collective Research Centres. The main financial resources derive from firms, an initial subsidy from the Ministry of Economic Affairs, and occasionally subsidies from government institutions. The objective of these Centres is to stimulate scientific and technological research in its branch and to provide documentation and information services.

Denmark

Considerable research and development activities take place at the institutes established by the Danish Academy of Technical Science. The institutes carry out product development for single enterprises to only a modest extent, but do undertake product and process development of a more general nature for the industrial sector to which they are connected.

In addition to the above-mentioned institutes, twenty-three smaller non-profit institutes receive State support. These institutes are highly specialized either within a specific line of industry or in a specific technology, e.g.: Danish Research Centre for applied Electronics, the Danish Welding Institute, Danish Hydraulic Institute, the Danish Isotope Centre, the Danish Ship Research Laboratory and the Danish Textile Institute. The Danish Building Research Institute has the task of improving quality, productivity and competitiveness of the building industry. It also undertakes technological and economic research and development work in this field.

Federal Republic of Germany

The Fraunhofer Society for the Advancement of Applied Research (Fraunhofer Gesellschaft, FhG) maintains and operates about twenty-five research institutes and centres with a total of about 2,000 employees. The functions of the FhG, which is designed to serve as one of the primary mechanisms for bridging the gap between scientific research and industry, are: to carry out applied technological R & D, to analyse the needs of industry to determine which research problems should be investigated further, and to furnish advice concerning industrial research problems. About 40 per cent of FhG funds derived from contract research with public institutions and private companies, the remainder coming from the Federal and Länder governments' base-funding.

The Confederation of Industrial Research Associations (Arbeitsgemeinschaft Industrieller Forschungsvereinigungen AIF) provides a forum for the exchange of ideas and experiences between member associations, co-ordinates projects, advises on the establishment of new industrial research associations and serves as an intermediary between the Industrial Research Associations and Federal and Länder governments. The Associations receive about two-thirds of their funds from industrial contributions, the remainder being derived from a supporting programme of the Federal Ministry of Economics, which is administered by the AIF.

The co-operative research projects supported by this programme aim at problems common to a whole branch of industry. The research is mainly performed in sixty-three Industrial Research Institutes. Some of these institutes are independent bodies established by their industries while others are established at universities, either by the university or by industry.

The West German government has recently introduced a scheme whereby small firms can obtain a subsidy of 30 per cent of the cost of subcontracting R & D to the various infrastructural institutes. In this way, it is hoped to encourage non-R & D performing firms to become involved in innovative developments.

France

'Centres Techniques Industriels' (technical industrial centres) were designed to be of service to a particular industrial branch. The majority of sectors covered by these centres include a great number of small and medium-sized firms. The technical centres possess services and equipment which smaller and medium-sized firms are not themselves able to maintain. The financial resources of the centres are derived from a parafiscal tax and dues given by individual firms. There are about thirty technical centres with a total employment of about 6,000.

The objectives of the technical centres are: to conserve, perfect and diffuse technical knowledge by applied research that is of general interest to industry. In general, the choice of research programmes is determined in collaboration with the industry branch. These research programmes form about two-thirds of the centres' expenditure. Other services of the centres are important as well. These forms of assistance include technical assistance, assisting small and medium-sized firms in making choices for new materials, new processes, etc., and information and documentation.

The above activities make the industrial centres the mediators between fundamental research and industry. Apart from the parafiscal tax mentioned above, the government (the Ministry of Industry) offers other forms of aid to the technical centres:

- research contracts for research on subjects of general interest such as energy economics for industrial use, rational use of raw materials and the environment. 'Aide au prédéveloppement' to stimulate the effective use of the centres' results by industry is also available.

As in West Germany, the French government has recently introduced a scheme of subsidies for the cost of R & D work subcontracted to research institutes. In this case, the subsidy amounts to 25 per cent of the cost.

Italy

In Italy most collective research is carried out in collective industrial research institutes financed mainly by levies on firms. The remaining funds come from the government. In the last fifty years institutes have been established for the following sectors: paper, cellulose and textile fibres, oils and fats, fuels, silk, skins and tanning materials, citrus fruit extracts and derivates, food processing and glass. New institutes in industrial sectors like wood, ceramics and plastics will be established in the future. The aim is to promote technological progress in particular sectors by means of studies, analyses and research. Their main activity is centred around applied research for small and medium-sized enterprises (including documentation, training and product analyses). The research in these institutes is carried out in the context of independent research programmes or on the request of firms belonging to the sector.

The funds of the collective research institutes are derived from: contributions from the central government and the local authority (20 per cent), parafiscal contributions from the firms in the sector concerned (60 per cent), and payment for analysis and consulting on the part of individual firms (20 per cent).

A second infrastructural device in Italy is the Research Centres, which work for special branches of industry. They differ from the Collective

Research Institutes in that they are supported by only a limited number of firms. The main methods of financing are:

- a controlling interest by Istituto Mobiliare Italian (IMI), within the framework of the fund for applied research (FRA), backed up by a capital contribution from a limited number of public or private firms in the case of Tecnomare, Tecnocasa, Tecnotessile, Tecnoformac and Sistema Automatico Organizzazione Sanitaria (SAGO);
- financing by ENEL, supplemented by a large income from contract work; Centro Informazioni Studi Esperienze (CISE), Istituto Sperimentale Modelli e Strutture (ISMES) and Centro Eletrotecnico Sperimentale Italiano Giacinto Motto (CESI);
- IRI-controlled industrial firms, in some cases with the minority participation of other public or private companies, e.g. the Centro Studi e Laboratori Telecommunicazioni (CSELT), Centro Studi di Tecnica Navale (CETENA), and the Centro Sperimentale Metallurgico (CSM).
- lastly, financing through donations, supplemented by income from contract work.

The 'Consiglio Nazionale Ricerche' (CNR) plays an important role in public research. A large number of laboratories and research centres are attached to this body. Some of them perform research of an applied nature and maintain contacts with industry either as consultants or in some general form of collaboration.

Italian Law 183/76, Article 13, provides for the 'Mezzogiorno', which are incentives for the investment in and the expansion and development of scientific and technological research centres, especially those oriented to productive activities.

Law 675/77 provides financial incentives in various forms for projects aimed at the creation, expansion, or reorganization of laboratories and research centres linked with the development of productive activities of enterprises, or projects of co-operation between SMEs.

The Netherlands

The Organization for Applied Scientific Research (TNO) has been in operation since 1934. TNO is a non-profit R & D organization. Some of the thirty-five TNO institutes function very much like the collective research laboratories in other countries. TNO has a total staff of 5,000. The objectives of TNO are to provide industry with access to technology. Government support, through TNO, is directed towards R & D for community purposes, provision of up-to-date equipment, long-term research, technology transfer and costs of free information services. From the total costs about 50 per cent is financed by the government directly, the remainder being income from contract research for government and industry.

Projects carried out by TNO can be categorized under the following headings:

Pioneering research
Engineering research
Process and product development
Technical evaluation of new products and processes
Design of new products
Development of quality standards
Testing
Trouble shooting
Special analytical measurement services
Techno-economic studies
Implementation of new technologies
Equipment evaluation and acceptance testing
Technology assessment
Risk analysis
Offshore technology and oceanology.

The Stimulation Measure TNO provides grants for R & D projects carried out by TNO for a group of companies. Most beneficiaries of this measure are small and medium-sized enterprises and traditional branches of industry. There is a maximum grant of 50 per cent of the total cost of any product.

Finally, at TNO, a do-it-yourself laboratory has been established for SMEs, which contains workshops and test facilities which workers from SMEs can use directly. An advantage of this scheme is that it should foster good personal relationships between the SME workers and members of the institute with whom they come into daily contact.

United Kingdom

Although a number of government research institutes and laboratories perform collective industrial research in the UK, by far the greatest amount is undertaken by the Research Associations. The first Research Association was founded, with government support, in 1917, and today they number forty-two, the majority being industry specific, mainly in traditional areas. They are 'non-profit distributing' organizations operating for the benefit of their members, which are mainly UK companies, and they enjoy a semi-charitable status which affords them a measure of tax relief.

The ultimate financial decision-making body in most RAs is a Council, which consists of senior representatives from member firms and usually a representative from the appropriate government department. There is also, usually, a sub-committee or Board which is delegated to deal with major operational, financial and policy decisions. The industry representatives derive mainly from large firms.

From the early days, and up to about 1965, the main source of funding for research (approximately 60 per cent of the total cost) was membership subscriptions. These were normally voluntary, but in a few cases some form of levy on the industry was used. (The Cast Iron, Furniture and Wood RAs still operate through levies.) Most of the remaining funds (about 30 per cent) came from the UK government in the form of 'grant in aid' on the basis of approximately £1 of government money for £1 of subscription income initially. Right from the start the government money was intended as a 'pump priming exercise' in order to help get the RA going and the intent, which was by and large adhered to, was to reduce gradually the government contribution.

Since 1971, following the adoption of the Rothschild Principle (i.e. if a piece of research is to be done, there must be a customer who is prepared to pay and a contractor to do it), the RAs have been required to 'sell' their facilities to government who, as a customer, contracts with an RA to perform a certain piece of work for a certain cost within a certain time. Thus, the government acts as a proxy for the public, and in order to enable them to discharge this function, a number of Research Requirements Boards were created. Research Associations, government laboratories and individual firms are required to convince these boards of the public interest embodied in the work they wish to undertake in order to gain support.

Following the adoption of Rothschild's so-called 'customer-contractor' principle, the sources of RA funding break down approximately as follows:

- 35 per cent from members' subscriptions or levy.
- 15 per cent from Requirements Board contracts.
- 50 per cent from 'direct fee' work (sponsored research, consultancy, information, training, testing, etc.).

The main activities of RAs in the UK are:

- Co-operative (or collective) technical/scientific research, both laboratory and industry-based.

- Sponsored technical/scientific research, laboratory and factory-based.
- Consultancies, investigations and technical services, laboratory and factory-based.
- Standardization, testing and evaluations.

To a lesser, but growing extent, the following non-technical services are provided:

- Information dissemination.
- Training.
- Non-technical advisory services such as management, marketing, forecasting and planning.

Approximate breakdown of these activities at the present time yields:

- 40 per cent co-operative research and standards.
- 40 per cent technical consultancies and sponsored research.
- 15 per cent information and training.
- 5 per cent non-technical advisory services.

It can be seen that the Research Associations in the UK are drawing to the end of a decade of change: the governmental contribution to base funding has decreased, while the industrial percentage of total funding has increased significantly. As a result, it is probably true to say that the work of RAs has been drawn closer to the more urgent needs of industry. On the other hand, these changes have resulted in a marked reduction in long-term research and a clear focus on short-term problem solving. They have also led to an increase in the amount of company-specific contract research, as opposed to collective research. Finally, dissemination of results still represents only a relatively small part of the total work of RAs, and the reduction in government base support has made it more difficult for them to finance the provision of services to small firms.

Japan

Although there are a large number and variety in type of collective and semi-collective research and test centres in Japan, most of the collective research within the definition employed in this book is performed in three categories of institution: government establishments attached to a technical Ministry, local centres run by local and regional authorities and semi-public centres. They have no special legal status, and they are described separately below.

Government Centres

There are eighteen Government Industrial Technology Centres in Japan which are attached to the major technical Ministries. Their main task is to undertake R & D projects and to design and disseminate new technologies which respond to needs defined by their parent Ministries. The staff of these Centres often act as technical advisers to the Ministries to which they are attached. Direct technical assistance to industry is very rare and is normally confined to companies which are either very large or highly advanced technologically.

Government Centres are financed almost 100 per cent from public money. In 1976 95.8 per cent of finance derived from parent Ministries, and 4.1 per cent came from other Ministries.

The predominant activity of these Centres is applied research and development, which occupies about 90 per cent of the time of technical staff. The other services, traditionally supplied by collective research establishments (consultancy, testing, training and information services) receive little attention.

Government Centres carry out projects of a variety of kinds ranging from low budget, relatively short-term (two years) *general studies* to longer-term (five to ten years), high budget *national projects*.

Development projects are also undertaken in partnership with industry, which are based on the outcome of Centre-performed R & D programmes, and there is a limited amount of *contract research* for industry.

A marked common feature of the Centres is the low level of private sector involvement: all R & D projects are carried out under the tight control of the administration and the Centre directors. There is no direct participation by the private sector in decision making, although industry is a minority representative on the committees formed to establish general guidelines for the Centres. Informal relations between the Centres and industry are, however, well developed.

The Government Centres are non-industry specific and between them deal with a range of generic technologies.

Local Centres

The local authorities, which comprise forty-seven provincial and municipal authorities, have a large network of 600 Local Centres which exist to support local economic activity. Of these, 187 can be counted as Industrial Technology Centres. They are directly and solely responsible to their administering local authority and their employees are officials of those authorities. Some Industrial Technology Centres are industry specific while others deal with more general technologies. Although they do not control the local Industrial Technology Centres, the technical Ministries rely, to a large extent, on those working in their specific field since this allows them to minimize their own activities at the regional level.

Ninety per cent of each Centre's funding comes from the parent local authority, the remainder from paid services to firms (1–7 per cent) and various grants from MITI (3–9 per cent). MITI subsidies are provided directly by the Agency for Small Firms. Industry does not exert any direct influence on the operation of the Centres, but local firms do exert their influence through the Consultative Committees in the Industry Bureau of the various towns and cities and through the technical committees in the Centres.

The basic activity of the Local Centres is to provide direct assistance to local small firms (employment less than 300). They are generally in touch with between 10 per cent and 20 per cent of such firms in their geographic and technical areas. This assistance includes:

- Testing – accounts for 40 per cent to 50 per cent of staff working hours. There are a wide variety of test services including a 'do-it-yourself' facility.
- R & D – accounts for about 30 per cent of staff working hours. This includes 'general projects', which are initiated solely by the technical staff (90 per cent of total) and 'special projects' which represent the remaining 10 per cent. The latter comprise two types: co-ordinated research, involving between two and eight Local Centres and a Government Centre, and separate research involving only one Centre. In 1976 the Agency for Small Firms provided subsidies representing 50 per cent of total research costs.
- Training and Information – accounts for 5 per cent to 10 per cent of staff time. A unique feature of these Centres is their direct involvement in education: they provide training courses for the staff of small firms which, in 1976, involved 4,000 people.

Semi-public Centres

These Centres are industry specific, each industry having a direct involvement in defining its respective Centre's policy. Representatives from industry – mainly from technical or professional associations or larger firms – comprise a significant percentage of each Centre's management and technical committees. In addition, industry provides modest financial support in the form of voluntary contributions from large and medium-sized firms.

Table 9.3 Summary of collective research efforts in eight countries

Country	Collective research organizations	Manpower employed	Expenditure on collective research	Percentage of total industrial R & D expenditure	Source of funding
France	22 industrial technical centres	5,239 (1976)	F850 m. (1976)	5	7% (1978) Public financing 59% parafiscal taxes and voluntary subscriptions 34% own resources (private contracts etc.)
Japan	18 government centres; 187	4,115 (1976)	Y29,760 m.	1.0	100% government funding
	local centres	6,115 (1976)	Y31,000 m.	1.1	90% local authority; 3%–9% M.Y. 1%–7% industrial services
	5 semi-public centres	262 (1976)	Y2,765 m.	0.1	50%–90% direct or indirect subsidies Approx. 30% from testing and services. Less than 10% voluntary industry funds
Netherlands	TNO Organization for Industrial Research	1,700 (1978)	DFl.18.5 m. (1978)	Approx. 5	33% government stimulation subsidy 67% industry contributions

Republic of Ireland	IIRS and Agricultural institute	1,240 (1979)	£19 m.	–	IIRS: 37% fee-paid consultancy, 63% government grant Agric. Inst.: 100% government grant
Sweden	23 co-operative research institutes	–	£14 m.	–	50% government funding via STU 50% industry contributions
United Kingdom	42 research associations	4,718 (in 37 RAs) (1975)	£70 m. (42 RAs)	3.2	33% subscription income 2.66% statutory levy 27.3% government funding 33% industry contracts and contributions 5.16% information services etc.
United States	100 co-operative research organizations	–	$125 m. (1976)	Approx. 1% of industrial non-military R & D	20% government contracts 80% industry subscription contracts
	4 proposed generic research centres	–	Initially $6–8 m.		Initially mainly government funding reducing to 20% after 5 years
West Germany	63 collective research institutes	3,500	DM277 m.	3	75% membership fees 25% governmental support

Source: Rothwell and Zegveld (1981).

The staff of the Centres have numerous direct contacts with these firms, both for the provision of services (testing, technical advice and assistance, information and documentation, loan and demonstration of equipment) and for research activities undertaken in collaboration with groups of companies co-operating in the project. Firms are invoiced directly for the provision of these services which makes a major contribution towards covering the cost of their provision.

The essential distinguishing feature of the Japanese set-up is its extremely wide-reaching regional basis and the priority afforded to raising the technological level of small firms. The relatively high density of the network of local Centres makes it possible to provide immediate assistance to small firms, and to make industry aware of new technologies and administrative techniques.

A balance seems to have been achieved between giving the Centres the degree of independence needed to preserve their vitality (which is made easier by the relative independence of local authorities in Japan) and providing a flexible indirect controlling influence by MITI, which tries to guide the general policies of these establishments.

The main obstacles to the effective operation of these Centres are lack of staff mobility and the gulf that can often exist between industry, universities and Centres. The recent introduction of the semi-public Centres represents an attempt to find at least a partial cure for these difficulties.

Finally, Table 9.3 summarizes the collective industrial research efforts in a number of countries.

8. Support for selected technologies

So far the measures we have described have been general ones in that they, in most cases, apply to all SMEs in all branches of industry and technology. Recently, however, several governments have initiated policy measures aimed at specific technologies or product groups. Several of these are outlined briefly below.

Grant-in-aid for industrial R & D projects in the *Federal Republic of Germany* (BMFT–Projektförderung): the BMFT scheme of support for industrial R & D projects is the main instrument of public support to industrial innovation. Under this scheme grants in about fifteen specific fields of technology have been awarded to cover 50 per cent of the R & D costs of special projects, mainly in the field of energy, electronic data processing, transportation and traffic, space, communications and electronics, chemicals and marine R & D.

Because of its emphasis on the firms having considerable in-house R & D capabilities, this scheme undoubtedly favours larger firms. In the last few years, however, the BMFT scheme has been changed slightly to increase SME applications by:

- funding R & D projects in technological fields in which SMEs operate more frequently (e.g. scientific instruments);
- providing consultancy and information services, i.e.: information activities about government programmes for assisting R & D (e.g. by a mass distribution of information brochures); subsidized consultancy by industry organizations and chambers of commerce to assist SMEs in apply for government funds;
- simplifying the procedures for request and award of government funds.

The *French* Ministry of Industry has given priority to the following strategic sectors: electronic office requirement, consumer electronics, energy-saving equipment, undersea activities, bio-industry and industrial robots. In these strategic sectors the government will negotiate development contracts with individual companies, setting specific goals for sales, exports and jobs. Firms that make such commitments will receive tax incentives, subsidized loans and other official aids.

In the *Netherlands* an instrument called *Speerpuntenbeleid*, 'Spearhead Funds', provides funds for government participation in development programmes of selected industries which have a high risk factor, a long pay-back period and cover new fields of technology.

In the *United Kingdom* Launching Aid has been an official government measure since 1960, although there have been loans of a similar type since 1945. The objective of the measure is to reduce the commercial risks facing manufacturers during the development of products and advanced techniques. Repayment is made through a levy on sales of final products; during the time of development there is no interest.

The main aim of the Launching Aid was to restructure the British aircraft industry. Most of the Launching Aid has been spent on the Concorde project. In a modified form funds like the Launching Aid have been used for the computer industry. Between 1947 and 1975 about £1,500 m. were spent on Launching Aid. However, the importance for SMEs has been minor.

Japan

It is, perhaps, in Japan that the choice of certain strategic technologies and product groups is most marked. This is illustrated in Table 9.4. Financing for investment in these industries will come from MITI in collaboration with the Ministry of Finance and the Japan Development Bank (JDB). In the fiscal year 1981, the JDB lent about $4.5 billion, which was supported by parallel loans from the private banks.

Table 9.4 Areas of interest of Japanese industry

New Products	Energy Industries	Advanced, high-technology industries
Optical fibres	Coal liquefaction	Ultra-high-speed computers
Ceramics	Coal gasification	Space developments
Amorphous materials	Nuclear power	Ocean developments
High-efficiency resin	Solar energy	Aircraft
	Deep geothermal generation	

Source: Japanese Ministry of International Trade and Industry.

9. Public sector procurement

Although innovation-oriented public sector procurement is currently under development in a number of countries, in contrast to the situation in the US (as provided for in the Small Business Act), little special attention has to date been given to SMEs in this context.

In the *US* Federal Procurement Specialists in SBA offices throughout the country counsel small businesses on how to prepare bids and obtain prime contracts and subcontracts, direct them to relevant government procurement agencies, place their names on bidders' lists and supply information on research and development projects, new technology and assistance in technology transfer.

10. Management training

In *Canada*, CASE (Counselling Assistance for Small Enterprises) is a management counselling service wherein retired business persons act as counsellors on behalf of the Federal Business Development Bank (FBDB).

Its purpose is to assist owners and managers of business enterprises, particularly those of smaller size, to improve their methods of doing business. Also, it provides an opportunity for retired business people to contribute to the development of the small business community by making available a vast store of knowledge and experience. To be eligible, a business may already be established or be about to engage in business in Canada.

Any proprietorship, partnership or limited company conducting virtually any type of business enterprise in Canada can apply provided:

- the enterprise does not have more than seventy-five full-time employees;
- the enterprise has had prior discussion of its problem(s) with its appropriate business adviser(s).

Complimenting this programme are a number of provincially funded university student counselling programmes.

The FBDB conducts an extensive series of one-day management seminars at many centres across Canada. The seminar programmes are designed particularly for small business and cover a variety of topics related to small business management. A moderate registration fee is charged. The Bank also prepares seminars for specific industries in collaboration with industry associations and other organizations which present seminars to their members. The Bank prepares and distributes thirty-hour courses on small-business management topics to Ministries of Education across Canada for adult education programmes co-ordinated by those Ministries at local colleges.

In the *Netherlands* there exists the Foundation Kleinnood in which a number of large firms and banks co-operate in a scheme to make available to small firms management services comparable to the Canadian CASE set-up. At the end of 1981 some twenty counsellors were available.

The Netherlands Foundation for Business Administration of the Inter-University Institute for Business Administration in 1980 started courses for managers of small firms; a Small Business School.

Finally, the Project Industrial Innovation (PII), initiated in 1976, assists established SMEs and new entrants with their innovation strategy, and at the same time is aimed at stimulating commercial business consulting firms to enter this new area of consulting.

11. Summary of the main thrust of national government measures to assist SMEs in the different countries

In the earlier part of this chapter government measures designed to assist SMEs in different countries have been described. Because of the difficulty of obtaining directly comparable data for the different countries, the information presented does not claim to be exhaustive. We will now very briefly outline the main thrust of the government measures towards SMEs in a number of advanced market economies.

Canada

Following a detailed assessment of past innovation policies, Canada recently replaced a number of programmes with the Enterprise Development Programme. This represents a rational attempt to overcome identified weaknesses in previous programmes. The main aims of the EDP are to:

- decentralize administration for small projects and SMEs;
- involve the private sector in the decision-making process;
- focus on overall performance of the firm rather than on individual projects;
- ensure that innovation assistance is provided only in cases where the project represents a real risk in relation to the firm's total resources. Thus small projects in large firms will not attract support, but small projects in small firms will be funded.

Other marked features of Canadian assistance for SMEs are:

- emphasis on technology transfer, especially via research associations and institutes;
- provision of investment and risk capital for SMEs;
- provision of management training and services to SMEs;
- general emphasis on the regionalization of the administration of measures affecting SMEs.

Denmark

A novel feature within the Danish innovation assistance system is the Danish Innovation Centre which promotes the interests of inventors and SMEs. Other programmes in Denmark are:

- the Danish 'information for industry' service;
- training and information services provided by the technological institutes;
- R & D subsidies.

France

The three main thrusts of government innovation policy in France are:

- encouragement to SMEs to utilize the infrastructure and to stimulate collaborative research between various research institutes, universities and industrial research associations;
- provision of development credits;
- establishment of regional technology transfer and information centres, and regional R & D facilities for use by SMEs (i.e. the regionalization of SMEs assistance schemes).

The Republic of Ireland

Major features of government assistance to SMEs in the Republic of Ireland are:

- grants for new product and process development and regional grants for the establishment of small business;
- grants for overseas market research;
- encouragement for firms to interact more closely with universities and related institutions;
- a comprehensive range of technical consultancy and information services.

Japan

In Japan the main features of government aid to SMEs are:

- encouragement of collaborative effort and the establishment of joint facilities for SMEs;
- providing management and technical manpower training and assistance;
- provision of finance for SMEs;
- assistance to establish co-operative associations of SMEs;
- regionalization in the administration of measures for SMEs;
- provision of a range of tax concessions.

In Japan a strong tradition of establishing co-operative facilities and associations for SMEs, and co-ordinated trading by SMEs, is noticeable. A second marked feature of the Japanese industrial scene is the high level of involvement of industry in formulating governmental industry strategy and policy measures.

The Netherlands

The main thrusts of government policy towards SMEs are technology transfer and assistance in product development (TNO), assistance in the overall operation (RND) and financial assistance through development credits. A recent experimental programme (PII) aims at assisting with the overall innovation process at SMEs.

Sweden

Trends in Sweden are:

- the stimulation of inventors and manufacturers to find new product ideas and to innovate;
- provision of innovation, rather than just R & D, assistance;
- move towards decentralization in the administration of policy measures;
- more towards decentralization in the administration of policy measures;
- growth in the number of groupings of SMEs, the so-called Development Companies.

United Kingdom

Innovation assistance in the UK includes:

- assistance with licensing and new product development;
- encouraging collaboration between small firms;
- the promotion of technical and productivity services;
- management counselling services for SMEs;
- range of technical information services;
- assistance to SMEs in the use of microprocessor devices.

US

Small business' interests in the US are looked after primarily by the Small Business Administration. Aid from the SBA focuses mainly on three areas:

- a wide variety of loans for SMEs;
- provision of management counselling services;
- participation in public procurement.

Following a number of background studies, the NSF and the US Department of Commerce have instigated several highly innovative schemes, notably:

– NSFs Innovation Centres, intended to encourage entrepreneurship;
– Department of Commerce experiments in procurement and life cycle costing.

Federal Republic of Germany

There is a marked emphasis in West Germany on measures to promote technology transfer from various research institutes and the industrial research associations to SMEs, and special measures have recently been taken to promote the use in industry of certain specific technologies, e.g. microelectronics. Emphasis has also recently been given to measures to encourage SMEs to contract out R & D to the infrastructure. This is aimed to encourage those SMEs, which normally perform little or no R & D, to become actively involved in R & D and innovation.

Other important features of West Germany innovation policy are:

– establishment of a venture capital bank;
– assistance with the transfer of patents;
– R & D investment grants;
– regionalization in the administration of policy measures (based on the Länder system).

Finally it is worth noting that, rather than encouraging the formation of NTBFs, the Federal German government has preferred the reshaping of old firms into a more progressive and innovative mould.

12. General comments on government policy measures towards SMEs

Some brief general comments are offered here on a number of government SME policy measures. These comments are made in the light of the data presented in the previous sections of this chapter and elsewhere (Rothwell and Zegveld, 1978).

Research Institutes and Associations

In all the countries covered by this chapter, research institutes and associations, either wholly or partially sponsored by governments, play an important role as instruments of industrial policy. Table 9.5 lists the percentage of national R & D expenditure undertaken in government and non-profit organizations in a number of countries; in most cases this represents a significant proportion of total national R & D expenditure.

In most countries research institutes are the prime mechanism for

Table 9.5 Percentage of national R & D expenditure in government and non-profit organizations

Country	% of national R & D expenditure in government and non-profit organizations
US (1974)	18%
Japan (1972)	16%
UK (1969)	27%
France (1971)	29%
West Germany (1971)	14%
Netherlands (1972)	21%
Belgium (1971)	14%
Sweden (1970)	12%
Switzerland (1971)	6%
Norway (1973)	16%
Israel (1974)	16%

Source: Scientific Research in Israel, National Council for R & D, Israel, 1976.

technology transfer: their basic function is to encourage, and assist in, the application of science and technology in industry; they are the main link between industry and universities and government research laboratories, translating the results of academic research into a language industry can understand.

There is a particularly strong need for collective research institutes in the old-established industries which came into being before the scientific phase of the industrial revolution, and which have no traditions of research and development. Indeed, it is mainly within these sectors that such institutes have been established, and there seems no doubt that they have generally made a valuable contribution to technical progress in the various sectors. Other research institutions are cross-sectoral, dealing in such broadly applicable areas as metallurgy and production engineering.

Much of the work of research institutes (RIs) involves co-operative, or 'shared', research programmes, which deal with problems facing a whole industry sector (e.g. means to reduce wastage, improvement of working conditions, common standards, etc.). This is an area in which RIs can have an extremely valuable and wide-ranging impact on overall sectoral efficiency. Other work involves solving the day-to-day problems of individual firms and, very importantly, providing technical information and advice. A third area of work, which can present problems beyond the technical ones, is that of involvement in a particular firm's new product development project. Questions such as confidentiality and patent ownership can impose real barriers to this latter type of interaction. For this reason it might be that RIs within their current organizational structures are better suited for dealing with 'production process', rather than 'new product', innovations.

RIs can be especially useful working in areas that affect society as a whole, but which few firms in a sector have the time or resources to deal with properly, such as safety, energy conservation and environmental pollution. RIs can also pursue long-term, basic research relevant to a whole sector, but which few but the largest firms (particularly not SMEs) can afford to perform individually. Indeed, one of the problems facing RIs is that, in responding to industry's day-to-day requirements, they might neglect longer-term problems, and it may be that it is in this area that government support should be focused.

Evidence from Canada and Israel suggest that there is a threshold level below which RIs cannot operate effectively. If this is true, then governments should consider setting core funding levels to enable RIs at least to reach this threshold. As an alternative, they might assist in the formation of one or more 'umbrella' institutes (such as TNO) which incorporate a very wide range of skills and disciplines, and which constitute a comprehensive overall R & D effort.

Perhaps the major problem facing an RI is identifying firms that might benefit from its services, and convincing them to use these services. Probably about 5 per cent to 10 per cent of firms in a sector will be active innovators and will have been involved with an RI at one time or another; between 25 per cent to 40 per cent will have the potential for innovating, but need help in this; the remainder, because of their structure, management style, or whatever, will lack the ability to innovate, and there is little that can be done to change this. From the point of view of the RI, the second group is most important, and it is in identifying these firms that the major effort should go. Since this group is quite large, it is unlikely that the RI could identify and contact all its members. Consequently, any programmes aimed at this group should have a demonstration component so that the benefits of both innovation, and the use of an RI in this, can be brought to the other members' notice.

While many SMEs undoubtedly require technical assistance if they are to attempt to innovate technologically, by itself this might not be enough to ensure innovative success. An equally pressing need can exist for management expertise and marketing know-how. After all, evidence does strongly suggest that most innovations fail because of poor management and the failure to satisfy user needs. In the light of this, it seems surprising that RIs have not put more effort into offering management services, i.e. in assisting with the innovation process, rather than solely with the R & D or production technology aspects of the process. There is some evidence, however, to suggest that RIs and other research institutions are currently aware of this problem and are taking steps to extend the range of their services to encompass management and marketing aspects of new product development (Rothwell, 1980).

At this point it might be relevant to ask the question: what role do RIs play in meeting the requirements of small firms? There are some data available on this point (albeit rather out of date) concerning research associations in the UK. In a survey carried out by the Confederation of British Industry in 1961, comments were invited from a large number of firms of various sizes concerning the usefulness of co-operative research carried out through the research associations. Out of 300 firms that replied, the number submitting enquires to RIs was 103, only nine of which derived from firms with less than 300 employees.

The problems SMEs have in establishing good external communication might go some way towards explaining the lack of use, by SMEs, of RIs in the UK. Nevertheless, having said this, it is very much up to RIs to adopt a vigorous approach towards disseminating information about themselves and the services they have to offer. If they are to be really effective, they must go into industry, and especially to SMEs, and 'sell' themselves and their facilities: in other words, they must adopt an active rather than a passive stance. However, they might well need more government support to enable them to achieve this successfully.

Finally, despite the myriad problems of collective industrial research, it is clear that it is definitely on the increase on most countries. To a large extent this is due to a greater awareness on the part of governments of the potential utility of collective industrial research as an arm of government policy towards industry generally, and more specifically towards stimulating and assisting innovation; in particular collective industrial research is increasingly being used as a major component of government policy towards assisting small and medium-sized firms. It is also due to some extent to greater efforts on the part of collective industrial research organizations themselves to promote their services; they appear in many cases to be adopting a more positive stance and are actively 'marketing' their services in both industry and government.

While the modes of organization and financing of collective industrial research vary considerably from country to country, nevertheless there does appear to be a growing convergence in aims and practices. Certainly, a number of general trends in collective industrial research are observable internationally. These were initiated in the light of the various problems discussed above. The most significant of these trends can be summarized as follows:

- increasing strategic use by governments of collective industrial research as an arm of industry policy;
- greater emphasis on the provision of 'economic' services, such as management training, assistance with marketing, etc.: that is, collective research organizations are increasingly becoming involved in the complete process of innovation, rather than solely in the R & D end of that process;
- increased support from governments for the utilization of collective industrial research by SMEs, both by the provision of financial assistance for contract research and by the use of information brokers;
- the awareness within collective research organizations of their potential to assist SMEs – with or without governmental assistance – has generally also increased;
- there is a trend towards the performance of more generic research (notably in the field of microelectronics) and newly established, or proposed, collective research organizations in several countries have been of the generic type;
- collective industrial research organizations are generally performing a higher percentage of contract research for single firms or small groups of firms, rather than collective research for whole sectors of industry. This has resulted in a greater new product-orientation of research and a generally increased awareness of the problems and needs of industry;
- in a number of countries, services – especially to SMEs – are becoming increasingly regionalized;
- collective industrial research organizations in several countries are more and more involving other research organizations (universities, government research institutes) in their activities.

Thus, while the history and practice of collective industrial research has varied greatly from country to country (long-established and comprehensive in Japan; comprehensive with a strong bias towards small firms in West Germany; highly fragmented, with little government support or direction in the United States), attitudes, aims and practices are converging;

While this is partly due to the fact that the advanced nations face similar economic and industrial problems, it is also a result of governments becoming increasingly involved in policies for industrial innovation, and in particular of a growing awareness on their part of the potential utility of collective research as an important active component in these policies.

Role of the universities

Although we have not previously dealt separately with universities in this chapter, nevertheless in all the advanced economies a significant percentage of government financial support for R & D is allocated to universities and other institutions of higher education. This is demonstrated in Table 9.6 below.

Given these relatively high levels of R & D expenditure in universities, it is relevant to ask what impact they have on innovation in industry. Some data on this point are available from the UK. For example, of 1,667

Table 9.6 Percentage of national R & D expenditure in institutions of higher education

Country	% of national R & D expenditure in institutions of higher education
USA (1974)	12%
Japan (1972)	18%
UK (1969)	8%
France (1971)	15%
West Germany (1971)	19%
The Netherlands (1972)	19%
Belgium (1971)	29%
Sweden (1970)	23%
Switzerland (1971)	13%
Norway (1973)	33%
Israel (1974)	60%

Source: Scientific Research in Israel, National Council for Research and Development, Israel, July 1976.

important innovations introduced in the UK between 1950 and 1970, the original idea for only 2.52 per cent derived from universities.

Perhaps more pertinent here is the question of the interaction between universities and SMEs. Figure 9.1, taken from a report by the UK Universities and Industry Joint Committee (1970), shows the various ways in which companies use university R & D by size of company. It shows a marked pattern; that is, on all the measures of contact between industry and academia, small firms had by far the fewer contacts. Further, out of 403 firms employing less than 200, 75 per cent had no contact with universities; out of ninety-six firms with greater than 5,000 employees, only 9 per cent had no contact with universities.

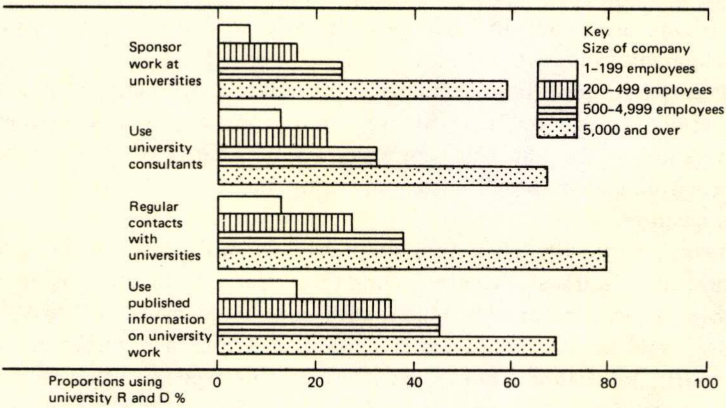

Fig. 9.1 Ways in which companies use university research and development – by size of company. *Source*: 'Industry, Science and the Universities', Universities and Industry Joint Committee, July 1970. Published by the CBI.

A correlation analysis on the data showed that a higher proportion of university-trained scientists in the senior management of smaller sized companies meant a greater likelihood of having contact with universities. As was seen earlier, however, small firms generally employ fewer (if any) technical graduates than do their larger counterparts. This clearly is an area for concern, especially since the need of SMEs for external technology from universities is so great.

A number of governments have established industrial liaison officers at universities, whose function is to increase the use by local industry of university facilities and expertise. This is a positive step which should go some way towards increasing industry's awareness of the technical potential available in universities, and should be of interest to SMEs in particular who generally lack in-house technical expertise. A much more effective means of achieving technology transfer can be found in West Germany where universities have their own institute for applied research, which carries out applied research and development on the assignment of industry. These institutes are located in the same building as the university, and bring together experts from a number of disciplines, e.g. physics, electronics, mechanical engineering.

Another interesting development is the establishment of university industrial parks in which small, high technology firms draw heavily on university science and technology. In a number of instances (e.g. in Israel) the universities themselves have a financial stake in one or more of these firms. In some countries (e.g. the UK) a number of 'university companies' exist that are active in technology transfer and product and process development (Smith, 1977).

Perhaps the most interesting, and innovative, experiment in this area is the establishment, by the NSF, of Innovation Centres at a number of universities in the US. This represents a very positive attempt to create an environment in which entrepreneurship can flourish and to generate new business.

From the results of a number of background studies in the United States, the National Science Foundation reached the conclusion that innovation was inseparably linked with entrepreneurship, and that there was a trend in the United States towards a decreasing number of entrepreneurs. Innovation centres (ICs) were conceived as vehicles within universities for stimulating technological innovation and for increasing the entrepreneurial tendencies of graduates as they pursued their careers. The ICs were designed to offer both formal education and practical experience in invention, innovation and entrepreneurship. Other objectives were to provide support for the independent inventor or entrepreneur, increase non-federal investment in R & D, and accelerate the commercialization of university inventions. In 1973 three ICs were established at different universities.

Special provisions were included in the NSF/IC agreements that encouraged ICs to derive income from their activities; for example, both inventors and the ICs could share in rights to patents developed during the course of centre activities.

The success of the IC experiment can be gauged from the following figures. To date (1978) the three ICs have between them:

– participated in the creation of over thirty new ventures, of which twenty-three have achieved sales of over $30 million;

- resulted in approximately 1,000 new jobs;
- generated over \$6 million in tax revenues (for a total NSF outlay of \$3 million);
- exposed over 2,000 students to instruction and/or experience in the entrepreneurial, invention and innovation processes;
- assisted in the evaluation of over 2,000 ideas for new products.

Similar structures are currently being established in Canada and the Republic of Ireland.

A second NSF initiative to improve university-industry interaction is the Technology Innovation Programme (TIP), which is directed towards shortening the time between university research results and commercial utilization (Wetmore, 1980).

A major TIP project builds upon the research results in programmable automation assembly from the University of Massachusetts, the Stanford Research Institute, and the Charles Stark Draper Laboratory, Inc. The co-operative project funds Westinghouse and the researchers to analyse ways in which the research results could be cost-effectively applied in developing an experimental automated programmable assembly system for batch assembly, which represents some 75 per cent of US manufacturer assembly operations. The work to date has already shown that this university-industry interaction increases the rate of technology transfer and increases both the effectiveness of the researchers and the ability of industry to utilize the research results.

The current phase of this project is experimenting with a fully integrated experimental assembly system which will provide significant information necessary for adoption throughout the batch assembly sector of industry and will significantly reduce the risk, financial and technological, normally associated with the initial application of research results. Since few companies will undertake an innovation without having a reasonable assurance that the innovation will be reliable, cost-effective and capturable, an experimental test in an industrial setting is an effective means to obtain industry acceptance. Moreover, universities do not normally perform the types of tests that develop data necessary for industry acceptance. Thus, an experimental project with a firm is frequently the only means to provide the data necessary for industry-wide acceptance of an innovation.

An interesting experiment has also begun in the UK at Manchester University, the so-called Teaching Company Scheme, which is jointly backed by the Science Research Council and the Department of Industry. Under this scheme, instead of taking higher degrees by working solely within the university laboratory, graduate engineers become 'associates' in partnership with a particular company.

They perform most of their work within the company on a specific project (often in production engineering), and ultimately take a higher degree based on this work. The aim of the scheme is to bridge the gap between the university and industry, raise the level of industrial technology and make an industrial career more attractive to graduates. Similar schemes are under way in three or four other universities. They should be of particular interest to SMEs who might acquire a high level of technical expertise at very low cost.

Finally, many universities contain schools of management, and it may be that these can be encouraged to interact more closely with local SMEs in imparting management skills. A knowledge of local conditions should make this type of management input particularly useful.

Inter-firm co-operation

One possible means that SMEs might employ to gain the benefits of scale in production, finance and marketing enjoyed by large firms, is the formation of loose groupings of firms. Firms belonging to these groupings would maintain a very high level of autonomy and retain the advantages of smallness, i.e. dynamism, flexibility and entrepreneurship.

A number of such groupings are already in existence, e.g. OGEM and Internatio Müller in the Netherlands – about 200 SMEs with central staff and other facilities; the development companies in Sweden; a wide range of co-operative efforts in Japan directed towards common production and marketing facilities and collaborative exporting – indeed, the establishment of common facilities among SMEs, represents a major thrust in government SME-related policy in Japan.

The establishment of these groupings provides SMEs with access to a high level of technology, marketing, accountancy and general management skills they might otherwise not obtain. In other words, such a set-up has real potential for enabling SMEs to overcome many of the disadvantages of small size. It might be that more governments, particularly at the local level, could offer financial and management assistance to stimulate the formation of many more such groupings.

Development subsidies

As we saw earlier, the major disadvantages of SMEs *vis-à-vis* large firms in innovation are resource-related, i.e. large firms generally have both the manpower and cash resources to enable them to undertake better high risk innovation projects, as well as the ability to survive failures. Subsidies are one means which governments can adopt to help reduce the risks involved in innovating and to redress the balance in favour of SMEs. However, in most countries the bulk of government cash has gone to financing projects in large firms.

Projects subsidized by governments have also tended to involve higher technical and financial risks, and markets of lower growth potential, than projects funded wholly by industrial companies. The fact that government-backed projects involve higher technical risk is not necessarily a bad thing: indeed, this might provide real justification for governments to become involved in the first place. The problem governments face is to identify high risk projects which also have high market potential, and it is doubtful whether government decision makers currently possess the competence to assess market prospects properly.

Government subsidies have mainly concentrated on the R & D end of the innovation process and have, by and large, ignored production and marketing. In some areas, however, the major costs, and sometimes the higher risks, have occurred during these latter phases of innovation. There is some indication that governments are becoming more aware of this, and are beginning to offer 'innovation', as opposed to 'R & D', subsidies. It might be that as governments become increasingly involved in funding the marketing end of innovations, they will also acquire greater competence in the field of market assessment.

The time and cost involved in seeking government financial assistance can often impose a major barrier to applications from SMEs, and means must be found to aid them in this process, perhaps via government cash and management assistance with the preparation of proposals. Markets are often subject to rapid change, and market opportunities can be quickly snapped up by competitors; SMEs cannot, therefore, afford to wait while the wheels of bureaucracy grind slowly towards a decision. If government subsidies are to aid SMEs in innovating for new markets, the decision-making process must be simplified and speeded up considerably, and a decision delivered before technical and market opportunities are lost.

Subsidies can be used to channel innovative effort along certain preferred technical paths, such as the adoption of microprocessors that replace mechanical devices, or the development of less energy-intensive processes. They might also be used to focus product and process development in areas of high export, or high import substitution, potential. It seems probable that such specific, directed subsidies would be more efficient than a general development subsidy in achieving particular government policy aims.

It was suggested earlier that most innovations appear to fail because of management, rather than technical or financial, problems. It might well be that in some cases governments can offer, or insist on, management training or guidance for SMEs which have obvious management weaknesses as a condition of being granted a subsidy.

Finally, SMEs in Europe face more fragmented markets than their counterparts in the US. They also suffer more through a relative paucity of private venture capital. This means that not only are the market risks greater for European SMEs, but also the availability of capital to enable them to undertake these risks is lower. There would, therefore, appear to be a greater justification for government subsidies for SMEs in Europe than in the US.

Procurement policy

Results of most studies of the innovation process overwhelmingly conclude that market demand, coupled to a clear understanding of user needs, is the most important single factor determining innovative success. In the light of this, and in view of the fact that public sector markets account for probably between a quarter and a half of total demand, it is surprising how unaware are those responsible for procurement in the public sector of their strategic potential for affecting both the rate and direction of innovation. Government procurement has, in fact, generally only played a significant role in the military area.

Public procurement might be used to reduce market entry risk of desirable new innovative products with, for example, better safety and pollution characteristics and extended operational lifetimes coupled to higher performance. Experiments in the US have shown that procurement, linked to life cycle costing and to value incentive clauses for improved performance, can produce positive results. It seems likely that performance specification is a potentially more useful tool than product specification in this respect.

Procurement might also be used in areas where innovation is clearly socially desirable, but not necessarily commercially viable. This might occur, for example, in some aspects of health care equipment.

In areas where procurement is undertaken at a local level, and where there is wide diversity in product or performance specifications (although no great diversity in need), centralized procurement agencies might be established to achieve demand aggregation. While this might result in some economies of scale for both the producer and the user, it would be unlikely to favour SMEs. However, where there exists a demand for relatively small numbers of specialized products, this could provide opportunities for SMEs, who might be afforded preferential treatment by the procuring body as part of an explicit SME-related government policy measure.

Regulation

Regulation can have a mixed impact on industrial innovation. On the one hand, it can force firms to innovate, perhaps unwillingly, in areas such as safety and environment; on the other hand, it can open up new opportunities in, for example, the production of pollution monitoring and control equipment. In the former case, however, governments might be forced to help SMEs meet the cost of complying with safety and environmental legislation; the cost might otherwise prove prohibitive to them (Rothwell, 1980 and 1981).

Government regulation can be fraught with difficulties. There might simply be too much of it thus putting the nation's industry (particularly its SMEs) at a disadvantage *vis-à-vis* foreign competition: it might be too inflexible and standards may be unrealistic or unscientific: lags may occur in issuing standards or certifying products. On the other hand, stringent home standards might gain a product or process a comparative quality advantage in export markets; they might also act as a very positive barrier to imports.

Taxation policy

Evidence has shown that prevailing tax rates can have a marked impact on the attitude of companies towards investing in R & D. Certainly managers of many SMEs in the UK feel that tax thresholds generally are too low and, because of this, the rewards from successful innovation are not sufficient to justify taking the risks involved in innovating. In West Germany high tax on the retained profits of SMEs – the very firms which need to re-invest profits to enable them to grow – was seen as a disincentive to the formation of NTBFs. There is no doubt that tax levels play a major part in establishing an environment which is either conducive to, or which imposes a barrier to, innovative and entrepreneurial endeavour on the part of SMEs and individuals.

While general tax levels affect firms of all sizes, most governments provide some concessions for SMEs. However, corporation tax thresholds are often seen to be too unrealistically low to have any significant impact on SMEs. Most governments also allow tax relief on R & D investments, but not on manufacturing and marketing start-up, both costly processes.

It might be that tax credits can be used to aid SMEs here particularly, for example, with market start-up abroad.

Level of government involvement

An important question concerning government involvement in industrial innovation is to what depth should this involvement go. Should governments concern themselves solely with overall policy making with respect to the rate and direction of technical change, and instigate measures accordingly, or should they take an active interest in individual projects? It seems probable that active involvement at the project level would be seen by managers – and might very well constitute – unwarranted interference. It is, anyway, doubtful whether most government officers possess the technical, managerial and marketing skills to enable them to assess properly the progress of individual projects. Governments would be best advised to concentrate on determining preferred direction of change, e.g. increased use by industry of microprocessors, and to formulate measures to achieve these ends. Having said this, however, it would be necessary for them to establish a system of assessment to determine which projects merit assistance in the first place.

Before instigating measures to assist SMEs, it might be that governments should take greater pains to discover in detail both the nature and severity of the problems facing them. This is a marked feature of the system in the US, where the NSF funded a series of background studies on the basis of which they formulated various policy measures, e.g. founding the Innovation Centres. A similar approach was adopted by the National Bureau of Standards in the US, and by the UK government, who instigated the Bolton Committee of Enquiry on Small Firms.

In deciding which measures to take, and in expediting them, it would seem sensible that governments should involve more the industries concerned. This would go some way towards bridging the gap that often exists between industry and government, and could improve both the quality of the measures taken and the degree to which they are used by companies. Certainly very close industry/government collaboration has paid handsome dividends in Japan.

Finally, there is little sense in governments having a battery of measures to assist industry if a large percentage of firms are unaware of their existence; this percentage is probably at its highest in the case of SMEs. Governments must take a more positive stance towards the dissemination of information describing their various schemes, and convince industry of their worth, otherwise their impact will be minimal. Governments need also to adopt the prime role of co-ordination, in order to ensure complementary interaction between their various measures, and to make certain that all the three 'inputs' to innovation mentioned earlier are available.

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10 SUMMARY AND DISCUSSION

During the past few years, as the economies of the western industrialized countries have either stagnated or moved deeper into recession, it has become increasingly evident from a variety of studies, and from official government policy statements towards industrial and technological development, that smaller firms are more and more being seen as one of the favoured vehicles for economic regeneration. In particular, SMEs are claimed to be more than averagely innovative, they are seen to be especially suitable as an instrument of regional development policy and, perhaps above all, they are believed to be the most potent potential generators of new jobs. Increasingly greater faith is thus being placed in SMEs as generators of economic growth, as prime sources of technological change and, through employment generation, as major factors in maintaining social stability. In an effort to establish a solid policy basis we have in this book accumulated and presented data relating to the above issues, and to others, in order to assess just what role SMEs have played in the past and are likely to play in the future in the economic, industrial, technological and, to some extent the social, life of the advanced market economies. In this chapter we have summarized and discussed a number of the principal points that have emerged in the preceding chapters.

First, as described in chapter 2, it is necessary to place SMEs and their role in a proper national and historical context. In other words, the role SMEs play in different national economies today reflects both official and social attitudes towards them, as well as differing national cultures and, of course, their own past performance.

In Japan, we see that while SMEs play a crucial part in the Japanese economy, their role appears to be very much an indirect one as suppliers of low cost, high quality, and often innovative, components and sub-assemblies to the major corporations. This system of closely bound sub-contractors appears in turn to afford the major corporations a great deal of flexibility in their operations. In the United States, on the other hand, SMEs are seen as the corner-stone of a free market economy, and support for SMEs is firmly enshrined in legislation. Here SMEs, by vigorously competing directly in the market-place, impart a certain dynamism to the economy, and they act as a countervailing force against overweening monopoly power. Within Europe, the role of SMEs, and attitudes towards them, vary a great deal from country to country. Nevertheless it is probably true to say that within Europe generally, interest has focused mainly on existing SMEs in the traditional and medium-technology sectors of the economy, in which they appear to have played their most important role.

As described in chapter 3, any comparison of the role SMEs play in the national economy, and especially any comparisons of relative efficiency, should be made on a sector-by-sector basis. Little is to be gained, for example, in comparing at an aggregate level the relative efficiency of SMEs in two economies if one is dominated by chemical, pharmaceutical and steel industries – which are today themselves dominated by very large capital intensive firms – and the other by mechanical engineering in which, generally, SMEs have a very significant role. Further, any purely economic assessment of the role of SMEs will not capture their sometimes equally important role as a force for social stability.

Further, there is little sense in utilizing aggregate data which might effectively involve comparing the innovativeness of small traditional firms in, for example, the areas of textiles and footwear, with small technology-based firms in, for example, the modern analytical instruments industry. Firms in the former areas might have been in existence for a century or more, be unwilling to grow or incapable of growth, and be involved with rather simple, incremental-type innovations (often acquired from external suppliers). Firms in the latter industry, in contrast, *must* be technologically innovative in order to survive, and might have high potential for rapid growth. Comparisons between the two are rather meaningless.

Perhaps the most important point to arise from chapter 3 is the recognition that any analysis of the role of SMEs in the national economy must definitely incorporate the time element. In other words, recognition must be given to the phenomenon that SMEs play different roles at different periods in time in different industries. In this respect, we fall very much on the side of Schumpeter, and have offered our own rather simplified model of industrial evolution in which the role of SMEs in an industry varies as the industry develops from newness to maturity.

In the early stages, SMEs represent the seed corn of the new industry, and are in the forefront of the development of the techno-economic combinations on which the future of the industry will be based. Technical entrepreneurship is crucial at this stage, during which most of the emphasis is placed on new product development and rapid market exploitation. Production systems are fluid and markets are initially rather undefined.

Rates of technological change are high, which is reflected in a great deal of inventive and innovative activity. Even during this phase, some large firms from established sectors are liable to be operating in the new industry.

As the industry grows, firm size increases, and new large entrants join the race from other areas, often through the provision of equity capital and by direct take-over. Markets are better defined and, via rapid production learning, productivity increases significantly. There remains still the possibility for major product innovation, and production-process technology is improving at a rapid rate. In order to survive, the firm must learn new skills in administration, financial control, marketing and distribution. During this phase the firm makes the transition from 'entrepreneurial' to 'managed'. There exists still the possibility for new small entrants.

As the technology matures, and as markets become highly specified, increasing emphasis is placed on production-process development and organizational change. Economies of scale in production and distribution become of prime importance as price competition rapidly intensifies. Take-overs and mergers occur more frequently, and the industry becomes strongly oligopolistic. Capital intensity is high. The major companies possess comprehensive in-house R & D capabilities. The price of entry becomes prohibitively high in the major product areas.

Thus we see a pattern in which small firms play a highly significant role at the beginning, but whose role as a major force in the industry diminishes, partly through take-overs and mergers, partly through the entry of established large firms from other areas, and most importantly through successful growth. We also see that the possibilities for new small entrants, on a significant scale, diminish as the costs of entry (capital, marketing, distribution, R & D) rapidly increase and, perhaps, as the technological possibilities for the development of novel products decrease. However, even in the latter stages of evolution, SMEs can play an important role as suppliers of specialist devices and as sub-contractors to the large firms; they can even still enter the industry by catering for narrow market niches.

As an approximate illustration of this model of industrial evolution, we described the post-war development of the semiconductor industry in the US. This clearly lent support to the model, but it did highlight the important role existing firms played in the process. For example, it showed the crucial part Bell Labs. played as a source of basis inventions over a period of many years; it described how several existing firms moved into the semi-conductor area and subsequently became of worldwide significance (notably Texas Instruments); it indicated the importance of existing large firms as a source of risk-capital for the entrepreneurial newcomers (e.g. Fairchild Camera Corporation); finally, it showed the incubator role of large firms – notably Bell Labs. – in spinning off new entrepreneurial activity via the route of highly gifted technical specialists. Thus we see a certain vital complementary interaction between the large and the small, the nature of the relationship being based on their relative strengths (e.g. small firm's entrepreneurship; large firm's access to resources).

Our model, of course, relates primarily to the changing role of new technology-based firms (NTBFs) and, during the post-war era, it would be difficult to propose similarly illustrative examples from Europe or Japan. Indeed, as we saw earlier, in comparison to the United States, NTBFs appear to have played only a relatively small part in the post-war economic and industrial regeneration of Western Europe. However, small industrial firms of many kinds have made a most significant, though variable, contribution to the West European economies, notably in such fields as mechanical engineering, scientific instruments and the general area of metal working. (The European semiconductor industries came about primarily through the efforts of existing large electronic companies.) They have also been crucially important as components suppliers to the West European automobile industries. It is most certainly doubtful whether many of the modern industries that have been the cornerstone of the post-war development in the advanced market economies, could have developed so rapidly and effectively without a 'hinterland' of small specialist suppliers and sub-contractors to the major firms, and this is probably truer of Japan than of anywhere else.

Much of the debate concerning firm size during the past decade or so has focused on the issue of innovativeness; specifically, are small firms inherently more innovative than their larger counterparts, or vice versa? Some eminent economists notably J. K. Galbraith, are very clearly in the large firm camp while others, equally clearly, favour small firms. Evidence presented in this book argues less for an 'either/or' approach, and more for a 'which, what, and when' approach. In other words, to 'which' sector, to 'what' aspect of innovation, and to 'when' in the industry cycle are we referring?

The analysis in chapter 4 clearly points to the fact that small firms can enjoy some marked advantages in certain aspects of innovation, notably good internal communication, high internal flexibility, rapid response to technical and market shifts and the possibilities for a dynamic, entrepreneurial management style. On the other hand, they can suffer from lack of technically qualified manpower, an inability to establish efficient external (technical) communication, lack of management expertise and a paucity of finance to fund high-risk endeavours, all areas in which large firms can enjoy a marked advantage. Thus small firms can enjoy a number of 'human' advantages in innovation, while large firms can enjoy a number of 'resources' related advantages of scale.

Concerning the question, 'which sector?', it is evident that SMEs are currently making a significant contribution to innovation in areas where capital requirements are relatively low, large scale distribution and servicing are not required, and where a large R & D effort is not essential. Thus SMEs have played only a minor part in innovation in the modern chemical and pharmaceutical industries, for example, and a significant role in the mechanical engineering and scientific instrument industries. The case of the chemical and pharmaceutical industries may now change, however, due to the appearance, at least in the US, of relatively small entrepreneurial firms in the bio-technology area combining forces with university-based R & D and with venture capital institutions. Also the data for the UK electronic computer industry show that the situation in a sector can change dramatically as a result of the emergence of new technological possibilities. Thus, while SMEs played more or less no role in innovation in the electronic computer industry between 1945 and 1970, they have enjoyed a highly significant role since 1970. This is the result of the development of solid state integrated circuits, most notably the micro-processor, which has enabled SMEs to enter the race via the production of mini- and micro-computers and associated equipment, which have themselves vastly increased the potential market for electronic computers. Thus a largely exogenous technological development has created many potential market niches for small, and sometimes not so small, specialist suppliers which, along with a marked reduction in capital requirements, has greatly reduced the entry threshold to the computer industry and made possible the growth in the numbers of new innovative entrants.

Turning now to the question of 'when?', it has been an often repeated theme in this book that SMEs probably make their major contribution to innovation (in the sense of pushing forward a new wave of technology, e.g. semiconductor technology) when the industry is in its early, rather fluid phase. The length of time this 'small firm dominant' period lasts will depend on many factors such as the rate at which the technology develops to maturity, the speed at which markets become well defined and at which market aggregation takes place – and, of course, the actual possibilities for aggregation – and the associated rate at which production learning occurs and scale economies begin to dominate. It was, for instance, suggested in chapter 4 that this evolutionary process occurred very much more rapidly in the case of integrated circuits than in the admittedly related case of discreet semiconductor devices.

It was also mentioned in chapter 4 that where rates of technical change are very high, specifically in the electro-optics and electronic process control industries, then in order to stay in the race small technically progressive firms are being compelled increasingly to seek co-operation with larger companies to enable them more rapidly to exploit their inventions. In other words, rapidly increasing R & D thresholds in some areas are leading to the early formation of oligopolies. They also, of course, pose an increasingly large barrier to new entrants.

An interesting aspect of the aggregated data on innovation by firms of different sizes in the UK since 1945 (Table 4.8) is that while the largest firms have progressively accounted for a greater share of the total number of innovations, during the past decade they have employed smaller units in which to develop these innovations. One explanation of this phenomenon is that large firms have succeeded in combining the 'human' benefits of small scale (entrepreneurship, flexibility, personal commitment) with the resource-related benefits of large scale (cash, qualified R & D manpower). Certainly there appears to be a trend in the UK for large firms to be willing to sacrifice some of the economic benefits of large scale in order to gain some of the human benefits of small scale (e.g. good labour relations), by building several units of medium size rather than a single large factory. A similar pattern can be observed in some large firms in Italy.

At the other end of the scale, groups of small firms in several countries have founded loosely bound consortia in order to support common R & D and/or management and/or production facilities, etc. Examples of this are the conglomerates in the Netherlands and the Development Companies in Sweden. Such collaborative operations are common in Japan and are there the object of governmental support and encouragement. They aim to maintain small firm autonomy while at the same time gaining scale economies in certain aspects of their operations.

Consideration of the question of the human benefits of small scale leads us naturally to the question of entrepreneurship – specifically technological entrepreneurship – and its appropriate environment. As we saw in chapter 5, entrepreneurship is an idiosyncratic act, depending as it does on the qualities and personal propensities of certain individuals. Dissatisfaction with their current lot, frustration, and the desire for independence, all play their part in causing individuals to strike out as technological entrepreneurs. Family background, level of education and national or local culture also appear to be significant formative factors.

Now, while we have expressed some doubt as to whether governmental or other agencies can actually 'create' entrepreneurs, we do believe strongly that, in addition to offering and stimulating pertinent educational programmes (like the US small business courses), they can create environments that favour, or disfavour, the entrepreneurial function. Most significant among these environmental factors appear to be the availability of risk capital, readily available sources of scientific and technological advice, and a receptive local market for the innovative products of new firms not having a proven track record as producers of goods. It is our contention that these factors are all amenable to deliberate policy manipulation on the part of both central and local governments.

While throughout this book we have emphasized the role of SMEs in economic regeneration and innovation, we nevertheless firmly accept that large firms, with their large resources, have a vital role to play. The ability of large modern corporations to become radically innovative in order to exploit the currently emerging set of techno-economic opportunities will be crucial to the speed at which the world economy rises out of the current recession. It is highly doubtful whether the upswing can come about solely through the efforts of new, entrepreneurial technology-based small firms: it does not seem feasible to suppose that the transfer of capital and manpower, and especially highly skilled technical and managerial manpower, to the new small firm sector will occur on anything like the required scale and in a sufficiently short time. This is especially true of Western Europe, where there is no strong tradition of independent technological entrepreneurship.

In Japan, the situation is rather different in that large Japanese corporations appear to demonstrate a remarkable degree of internal flexibility and technical progressiveness. These large corporations are moving rapidly into the 'newer' technological areas of bio-technology, video-systems and very high density integrated circuits, etc. In the United States and Europe, the large corporations generally need to adopt new internal structures if they are to become equally as flexible and progressive.

This has been recognized for some time, notably in the United States, where for some years now a number of major corporations have been experimenting with a variety of structures to stimulate and accommodate internal entrepreneurship. At the same time, some have employed dual strategies involving also the sponsoring of 'spin-off' small firms, or liaisons with small firms to harness their entrepreneurial drive, i.e. inside-outside ventures.

What this means is that large corporations have recognized the benefits of small scale in innovation (entrepreneurship, dynamism, flexibility) and have attempted to 'marry' these to their own resource-related benefits of large scale in R & D manpower, manufacturing capacity and know-how, and distribution. As we described in chapter 6, the various attempts at stimulating internal entrepreneurship have been fraught with difficulty – notably because of problems in interacting with existing, traditional management forms – but are nevertheless generally seen to have merit. Perhaps it is in the venture capital, sponsored spin-off, and other inside-outside ventures, that the greatest promise lies.

Turning now to the question of firm size and employment, it is probably true to say that the most important single reason for the recent rather dramatic, and widespread, increase in governmental interest in small firms is the belief in their potential for employment generation. Large Western firms are seen increasingly to shed jobs via rationalization and by foreign direct investment abroad including the LDCs. Small firms, especially new small firms, are seen to generate new jobs or, at the least, to represent relative employment stability. Data on this issue were presented in chapter 7.

Taking first aggregate data, indications are (except for Japan) that SMEs share in total national employment has generally declined during the past fifteen or so years. This has been paralleled by an increase in industrial concentration in the advanced market economies. Nevertheless, the figures show that the resistance against shedding labour is much stronger in SMEs as compared with large corporations. It should be taken into account, however, that SMEs represent a very different percentage of total national employment in different countries, this being relatively high in Japan, Israel and West Germany, and relatively low in the UK and France.

Data on the role of SMEs in the generation of *new* jobs is rather sparse, detailed national data currently being available from studies only in the United States and Canada. These studies do, however, indicate strongly that the majority of net new jobs in both countries during the past ten or fifteen years have been generated in smaller firms with, in the United States, employment below fifty and in Canada with employment below about 500. In both countries high employment loss was experienced by the larger firms. Further, the Canadian data suggested that the superior job generating performance of smaller firms over that of larger firms was more marked in the 1966–76 period, than in the 1961–66 period. The US data were closely paralleled by data from the East Midlands region of the UK, which might or might not be representative of the country as a whole.

Rather detailed regional data from the UK further illuminated the firm size-employment question. Specifically, it suggested that employment growth in established firms in the county of Leicestershire was greatest for small firms, especially those employing less than one hundred, than it was in larger firms. Moreover, the important issue of the age of the firm was also raised, and the data showed that employment growth in independent small firms occurred to a greater extent in the *younger* firms. Certainly in the case of small firms founded prior to 1947, employment declined.

Another important factor was that of ownership, and in particular the issue of the impact of external take-over on employment growth in small firms. Evidence from several regions in the US, and from the UK, strongly suggested that the performance of vigorous small firms, both in terms of growth in turn-over and in employment, declined following take-over by a larger firm.

Chapter 7 also discussed the role that new technology-based firms have played in employment generation in the United States. From a number of studies, the following conclusions were reached:

– In general, technology-based firms have, during the post-war era, generated new jobs at a greater rate than have firms in traditional and low technology areas.
– Young, technology-based firms generated new jobs at a greater rate than mature technology-based firms during the late 1960s and early 1970s.

Finally, evidence from France, Canada and the Republic of Ireland has indicated an association between employment generation and innovativeness. Specifically, in the case of France and Ireland, a high level of innovativeness was associated with a relatively high level of job creation. In the case of Canada, the introduction by firms of innovative new products and processes was associated in most cases with employment growth, especially in the case of new products and, for both products and processes, most notably in the case of smaller firms.

Thus, from the evidence presented in chapter 7, it was possible to conclude that there is a great deal of truth in the generally held belief in the superior employment-generating potential of smaller firms. However, this is only true of *some* small firms, notably *young* small firms, and especially firms that are also *technologically innovative*. This should not be taken to suggest, moreover, that the very considerable employment existing in large firms should be ignored, especially in large technology-based firms which, at least on the basis of evidence from the United States, continue to generate jobs,* albeit at a much lesser rate than their smaller counterparts. Rather, a dual strategy is necessary, aimed at the stimulation of the

* It is important to remember that the US studies cover the period only up to 1975, i.e. before the current recession really began to bite worldwide.

setting-up of technology-based new firms on the one hand, and at the regeneration of existing large firms on the other. Job generation via the creation, and the growth, of small firms is, anyway, likely to be significant only in the longer term.

The development of industrial production and industrial employment of the nine European Community Countries and the US can best be compared by showing the pertinent graphs of chapter 7 on the same relative scale. This comparison is presented in Figure 10.1, which clearly shows a dramatic relative decrease in employment in the industrial production sector over the period of 1964–80 for the EC-9 as compared to the US. Although such factors as the relatively lower increases in productivity in the US have played an important role here, it must be recognized that the rapidly increased capital intensity of mature industries in Europe was substantially stimulated by wage-push factors. Furthermore, a major share of the difference in employment in industrial production ought to be attributed to the fact that a substantial number of the many NTBFs established in the US in the 1960s and 1970s, have been reaching employment levels that now contribute substantially to the national employment figure. In short, our analysis suggests that the cause of the difference, and divergence, in employment in industrial production in Europe versus the US ought to be found in a higher capital intensity of mature industry and a much lower addition at the front end of the overall product cycle through NTBFs. When one considers that the European employment figures in Table 10.1 refer to 'all industry' (including, for example, mining), while the US figures are for 'manufacturing industry' only, the divergence between the two might be even greater than the graphs suggest.

An interesting issue raised in chapter 7 was that of regional variations in the contribution of wholly new establishments to employment generation. It was seen that new firms played a more significant role in total new job generation in the relatively more prosperous areas of the UK than in the assisted areas.* The Silicon Valley phenomenon in the United States represented an example *par excellence* of the strong influence of regional factors on the creation and growth of new innovative firms. In chapter 8 we took up the theme of regional variations in innovativeness and discussed a number of initiatives currently being taken in several countries to stimulate innovativeness at the local level.

Firstly, in chapter 8 we established, at least for the UK, that innovation does indeed appear to be a local (regional) phenomenon, which is probably

*It is also an interesting point that while the rate of new start-up remained more or less constant between 1947 and 1968 in the county of Leicestershire, between 1968 and 1975 it increased by about 30 per cent.

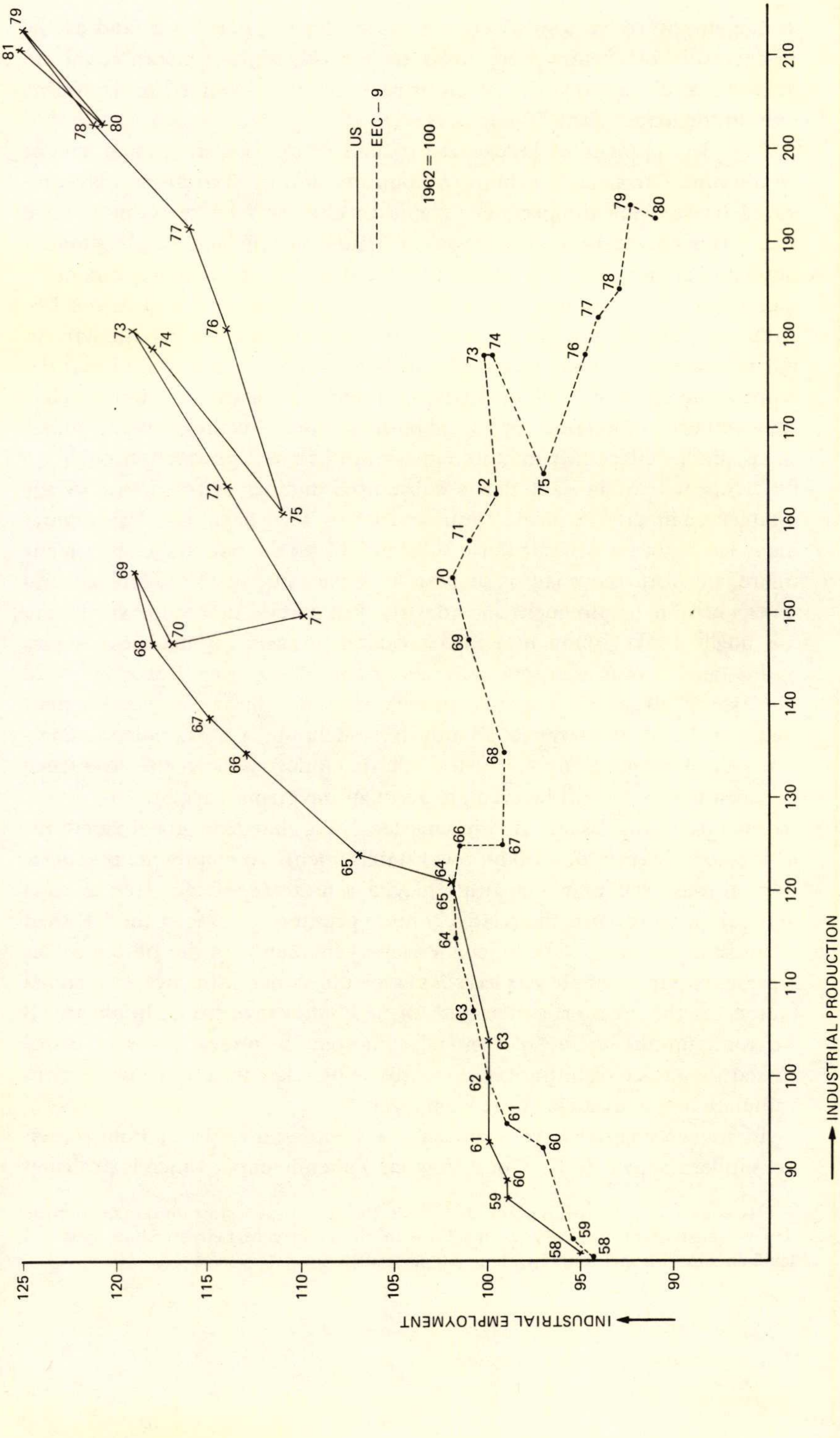

Fig. 10.1 Manufacturing output and employment in EEC-9 and the US.

true for most, if not all, of the advanced market economies. Both large and small firms produced more innovations in the prosperous South Eastern region of the UK than might be expected. Small firms, however, performed reasonably well in all regions, whereas outside the South East large firms performed rather poorly. The data also indicated an internal product cycle in the UK: in other words, intra-regional diffusion of new innovations dominated, with mainly only rather mature products being transferred to branch plants in other regions for manufacture. In those cases in which innovations were produced by independent single plant companies, the majority derived from small firms.

Evidence also suggested that small firms are generally rather closely bound to local markets, often supplying only one or two large local companies. If, as in the development regions in most countries, these large firms are operating predominately in traditional low technology areas, then this can pose an effective barrier to innovativeness on the part of the small suppliers. The encouragement of large, progressive, technology-based firms to the regions might therefore be seen as a suitable vehicle for regional development since this should provide innovative market demand for small local firms. What the data in chapter 8 suggested most strongly, however, is that new, innovative, independent small companies are perhaps the most suitable vehicle for regional regeneration via innovation. This then raises the question of how to go about creating the appropriate local 'innovation infrastructure' necessary for the stimulation of such firms.

A fair number of attempts are currently being made in a number of countries to establish such an infrastructure. These range from regional development companies to university, and other, science parks. An interesting, and promising, trend is the number of joint public/private initiatives in which local authorities and chambers of commerce are collaborating with large local companies in order to assist innovation in existing small firms and to encourage new technology-based start-ups (e.g. the St Helens Trust in the UK and Finpiemonte in Italy).

In all cases the initiatives described in chapter 8 were piecemeal and lacked direction and co-ordination at both the national and local levels. A number of governments do, however, appear to be becoming increasingly aware of the need for local innovation initiatives and seem, rather tentatively, to be moving towards more coherent policies.

Initiatives on the part of central governments should not, moreover, be taken as an alternative to local public and private (or mixed) initiatives; rather they should be designed to, and be seen to, complement them. To create a regional innovation infrastructure requires establishing a complex, and complementary, set of conditions with regard to supply, demand, and the general environment.

On the supply side, we require access to sources of scientific and technological expertise, local sources of capital, especially risk capital, the provision of premises, and a local availability of skilled labour. On the demand side, we require innovative market-pull, either from local industry and commerce, or via innovation-oriented local authority purchasing, or preferably both. In relation to environmental factors, such things as tax incentives, a minimum of local authority red tape, a favourable regulatory climate, and the availability of a range of services are important. To facilitate the inflow, if required, of suitably skilled labour, flexibility in local authority housing practice might be necessary. Establishing the conditions for an innovation infrastructure is clearly, then, a complex process, requiring a great deal of co-ordination between various local authorities and between these and central government. It is not an easy task; it is however, a desirable, and perhaps even an essential, one.

Turning now to the issue of government policy towards SMEs, in chapter 9 we have provided a detailed inventory of policy tools in various countries that were designed primarily to assist SMEs in their innovatory endeavours. We then presented a discussion of a number of the limitations to these policy tools, as well as some of the problems confronted in the past during their implementation. We also highlighted certain recent trends in SME innovation policy in the different countries.

In order to discuss sensibly the question of government policy towards small and medium-sized firms, it is really necessary first to distinguish between two basic classes of firm:

(a) established SMEs;
(b) new technology-based SMEs (NTBFs).

Firms in category (a) can be further divided into two sub-categories:

(i) firms operating with mature technologies in traditional areas (e.g. the foot-wear industry);
(ii) innovative firms operating in the modern industries (e.g. scientific instruments).

Firms in sub-category (i) require mainly access to existing technology in order to improve the quality of their products and the efficiency of their production processes. They can, perhaps, be best served by (collective) industrial research organizations backed by governmental funding. Microelectronics-based devices can offer both threats and opportunities to such firms. Firms in sub-category (i) can probably have only limited potential for major innovation and for employment generation, or for use in regional development policy.

Firms in sub-category (ii) were seen to suffer from a number of potential disadvantages *vis-à-vis* their larger counterparts in attempting to innovate. Among the most important of these are:

- lack of highly qualified technical manpower;
- problems in establishing communications with external sources of scientific and technological expertise and advice;
- lack of suitably qualified management to enable them properly to plan and co-ordinate their innovatory endeavours;
- lack of capital to fund high risk innovations, and an associated inability to spread the risk over a portfolio of projects;
- inability to obtain static production scale economies and scale economies in marketing and distribution;
- inability to offer an integrated range of products;
- inability to finance market start-up abroad.

On the other hand, we saw that such firms can often enjoy an advantage over their larger counterparts in internal communication and their ability to respond rapidly to exploit new technical and market opportunities. They generally provide specialist products for specific market segments. There exists, as we saw, evidence to suggest that in some areas (where capital costs are low and where R & D requirements are not too high) such firms play an inordinately large role in total sectoral innovations. They have high potential for growth and are suitable vehicles for regional development policy. As such they merit strong governmental support.

For many years governments have provided a battery of measures to assist SMEs in category (a). Measures common to most advanced market economies are:

- a network of (collective) industrial research organizations;
- provision of technical and other information services;
- provision of development credits;
- tax concessions;
- assistance with exports (e.g. export credit guarantees);
- a patent service.

Some recent trends, common to a number of countries, are:

- schemes specifically designed to assist SMEs to adapt and use microelectronics;

- the decentralization and regional administration of innovation measures, which is an implicit recognition that small firm innovation is often a local phenomenon;
- encouragement of co-operative efforts among SMEs;
- incentives for SMEs to contract out R & D to the infrastructure and generally to increase its utilization by SMEs;
- some novel experiments to increase the utility of research institutions and universities to industry;
- increased involvement of (collective) industrial research institutes in SMEs' problems of production, management and marketing, and not just R & D.

While firms in category (a)(ii) are of importance from the point of view of technology policy, firms in category (a)(i) are important to social policy since they represent a large percentage of total employment in the development areas and in the declining inner city areas in a number of countries. The latter are thus worth upgrading technologically where possible.

Turning now to firms in category (b) (NTBFs), there is little doubt that their main requirement is for venture capital to fund their start-up and early establishment. In all countries outside the US, both private and public venture capital to fund NTBF formation has been scarce, and in the US the bulk of venture capital has derived from private sources. Even in the US, however, during the mid 1970s, the flow of private venture capital almost dried up (although it has recently vigorously revived), and to compensate for this, at least partially, the Small Business Administration introduced its Small Business Investment Corporation programme and the National Science Foundation initiated its Small Business Innovation Program.

Because of the generally unsatisfactory nature of venture capital markets almost everywhere, governments have increasingly intervened in this area, and a comprehensive list of public venture capital schemes in a number of OECD member countries was provided in chapter 9. Among the most recent trends are:

- the establishment of public finance corporations, which generally operate by taking equity stakes or providing loans convertible into share capital (e.g. the British Technology Group);
- the promotion of the setting-up of *ad hoc* private venture capital companies, through special tax incentives;
- the development of schemes for guaranteeing bank loans for setting-up new innovating firms.

It is small firms in category (b) that are, in the present era of rapid technological development, potentially the most potent force for economic regeneration. They generally operate in areas of newly emerging technology and, if successful, can generate a great deal of new employment. Certainly within Europe, much greater effort is needed to stimulate the formation and growth of such firms on a large scale.

For all classes of small firms, but especially for those operating in rapidly changing markets and with fast developing technologies, a major requirement of any government scheme is high speed response. Decision makers in government or elsewhere should be in a position to provide an answer fairly rapidly; otherwise the new techno-economic opportunity for the firm is likely to be lost. A second requirement of such schemes is relative simplicity. Complex and involved application procedures can be beyond the resources of small firms to cope, and there is evidence to suggest that because of lengthy and complicated procedures, many managers (often of especially promising small firms) simply do not bother to apply for aid.

There also exists evidence to suggest that many small firm managers are simply unaware of the range of measures available to them. This means that governments should adopt a more active approach towards information dissemination. Further, having achieved awareness amongst small firms, governments might consider providing expertise and financial aid during the preparation of applications. It is widely recognized that, in comparison to those of large firms, applications from SMEs are often of rather low quality, leading to a high rate of rejection.

There is also the question of co-ordination between different measures. Because measures derive often from a variety of government agencies (regulatory, fiscal, technological, export), each normally occupied solely with its own particular area of interest, co-ordination between a frequently wide range of such measures is in most cases sadly lacking. Indeed, in some instances, measures proposed by different agencies are seen to be in contradiction to each other. Government thus has the vital role to play of co-ordinator, seeking to establish a complementary set of measures relating to all aspects of innovation, from R & D through to marketing. This might, perhaps, be best achieved through the establishment of a separate Small Business Agency as in the United States.

It must also be recognized that, in the advanced market economies, governments can only support and complement the innovative potential of private companies; they can never substitute for this in any marked degree. Government initiatives can attempt to create a climate in which innovation occurs and entrepreneurship and new firm start-up can take place; they can intervene in a variety of ways to assist firms in their innovatory endeavours; they can remove perceived barriers to innovation; there is, though, little they can do directly to affect the internal company transformation process. In other words, governments can encourage and enhance the performance of competent, technically progressive management; they cannot, however, fully compensate for incompetent management.

Because of the very large number of government measures presently available to advance innovation in SMEs, the development of a framework to assess these government initiatives seems urgently required. In a recent report, the General Accounting Office of the US (PAD-81-15, 7 July 1981) made the following distinction:

> To satisfy the criteria for conditions *necessary* for fostering small business innovation, Federal initiatives should:
> - encourage exploitation of technological opportunity;
> - ensure managerial and technical capacity of individual firms;
> - ensure adequacy of financial and human resources throughout the innovation process; and
> - promote innovation in technologies or industries in which small businesses can assemble requisite resources.
>
> To satisfy the criteria for conditions *important* in fostering small business innovation, Federal initiatives should:
> - stimulate creation and augmentation of technological opportunity; and;
> - increase availability of financial and human resources.
>
> To satisfy the criteria for conditions *desirable* for fostering small business innovation, Federal initiatives should:
> - address enough incentives and barriers to influence the balance between them positively.

Having put forward the requirement of the development of a framework to assess government measures towards SMEs in general, the same position ought to be taken towards the different roles of the technical-scientific infrastructure in particular. This issue has been addressed by the OECD in its report 'The Future of University Research' (OECD-1981) but also more generally concerns the overall government financed R & D complex. The distinction should be made here between the *research and development* orientation, the *transfer of knowledge* orientation and the *innovation management consultancy* orientation.

To summarize, we can say with some confidence that the recent surge of interest on the part of governments in SMEs has been vindicated by the evidence presented in this book. SMEs have been, and in general continue to be, technologically innovative; technology-based new SMEs do play an important part in the emergence of new technologies and in economic growth; SMEs, and particularly young technology-based SMEs, do make an exceptional contribution to employment creation; SMEs, and again especially young independent SMEs, do represent an important vehicle for regional regeneration; SMEs are important to social policy as well as to technology policy. We would once again, however, like to stress the complementary interaction between SMEs and their larger counterparts: future economic development will be based on a combination of vigorous new technology-based SMEs, and the regenerative efforts of large existing technology-based firms. The two will in many cases operate in a complementary and collaborative manner. Both are desirable. Both are essential.

INDEX

As in the text, this index uses the following abbreviations: NTBFs = New technology-based firms; R & D = Research and development; SMEs = Small and medium-sized enterprises.

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