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Arne Isaksen

Location and innovation. Geographical variations in innovative activity in Norwegian manufacturing industry

Arne Isaksen
STEP group
Storgt. 1
N-0155 Oslo
Norway

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STEP group

Studies in technology, innovation and economic policy
Studier i teknologi, innovasjon og økonomisk politikk

Storgaten 1, N-0155 Oslo, Norway
Telephone +47 2247 7310
Fax: +47 2242 9533
Web: http://www.step.no/

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Preface

This report was originally written in Norwegian, as a part of the research on regional systems of innovation that the STEP group carries out for the Ministry of Local Government and Labour. Sara Skodbo has done the greater part of the translation into English.

Summary

This report uses the results of a national survey of Norwegian manufacturing innovation to chart geographical variations in innovative activity in Norway. There are many reasons to carry out this type of mapping. Firstly, innovation and technological change are central to economic growth in developed countries. Secondly, innovation is largely a territorial phenomenon, that is to say, the innovation process is in part based on resources that are location-specific, i.e. resources which are tied to particular places and cannot be copied or reproduced elsewhere. Thirdly, innovation occurs differently in different regions, depending on the firm and industry structure, as well as on varying social and cultural conditions. It is, therefore, essential to understand how the innovation process takes place, in order to develop a regional innovation policy tailored to suit varying local conditions.

Two regional innovation models

Two distinct models of regional innovation development form the starting point for the analysis of geographical variation in innovative activity. These models present different understandings of how innovation takes place, as well as of *where* (in what kind of areas) innovative activity most often occurs. The first model has as its starting point the linear innovation model. Research and development (R&D) is assumed to form the basis for innovation. It is presumed that innovative activity, in the main, takes place within large companies, which tend to locate R&D in the most central regions. Small innovative firms also locate themselves in central regions. Thus the linear innovation model anticipates a geographic concentration of innovative activity.

The alternative - network based - model, takes modern innovation theory as its starting point, where innovation is understood as a process of interaction between firms and their environment. Proximity to other firms and institutions is important in many circumstances. Further, innovation involves many factors other than “pure” R&D; for instance uncodified, practical skills amongst the work force can be of great importance. This model considers innovative activity to be more widely spread than in the linear innovation model.

One of the aims of this report is to establish which of these two models offers the greatest insight in to the functioning of the innovation process in different areas in Norway. This provides the basis for a discussion of policy-implications, as the two models have widely different consequences for regional innovation policy.

It is a natural consequence of the linear innovation model to concentrate on building up R&D in the regions, or on linking regional firms to R&D milieus in more central areas. On the other hand the network-based model would suggest that an important aim of regional innovation policy is to create regional innovation systems, or to link regional firms to larger innovation systems. Innovation systems are made up of much more than R&D alone. Further, a central feature of this approach is that policy must be adjusted to suit differing regional conditions.

The extent of innovative activity

Two kinds of empirical investigation are carried out in order to chart and attempt to explain the geographical variations in innovative activity in Norwegian manufacturing. Firstly the *extent of innovative activity* is analysed. The indicators used are the share of firms in different areas with innovation costs and the share of firms producing new or significantly altered products during the last three years. The main conclusions drawn from this analysis are:

1. The share of firms that are innovative is greatest in the most central areas of Norway. However, these areas do not display massively greater shares of innovative firms. This is especially true when adjustments are made to account for local industry and firm structure. Thus the high share of innovative firms to be found in the six largest city communes in Norway can be ascribed to the fact that these areas are dominant in terms of innovative industries and size categories. The city-communes have a relatively large number of firms belonging to industries and size categories that display high rates of innovative firms on a national basis. These areas do not display particularly high levels of innovation among firms within the individual industries and size categories.
2. The share of innovative firms is also relatively large in those communes where manufacturing is important, or where specialisation within particular sectors is found. On the whole there is an even spread of innovative firms across large areas of Norway.
3. The share of innovative manufacturing firms is clearly smallest in the peripheral areas of Norway and in those areas that are dominated by primary industries. These areas face two problems: a relatively high number of firms within non-innovative industries, as well as a small proportion of innovative firms within individual sectors.

The conclusion that there is a wide geographical spread of innovative activity agrees with the picture which emerges from other data on regional manufacturing development. A significant *geographic deconcentration* of jobs has been taking place in Norwegian manufacturing for many decades. The most central areas have experienced substantial decline job losses since 1970, while more peripheral areas experienced a growth during the 1980s and below average rates of decline during the early 1990s. It is likely that this deconcentration reflects the fact that firms in less central areas are often as innovative as city-firms in the same sector. In the long run most firms cannot compete solely on the grounds of low costs, but must also develop new products and processes.

The innovation process

The report also analyses *how innovation takes place* in different parts of Norway. The kind of innovation costs firms have, their aims, sources of information and the obstacles to innovation are charted. There are many similarities between the innovation processes in different parts of Norway. However, a pattern of centre-periphery variation is clear, which displays the following features:

1. Firms in central areas of Norway employ research and development in the innovation process to a greater degree. In less central areas innovation takes place in other ways. Firms in the latter areas devote resources to the purchase of

products and licenses, while trial production, production start-up and product design also feature relatively strongly.
2. Firms in different areas make use of different parts of the R&D sector. City-firms use basic research institutes (universities and public research institutes) to a greater degree, whilst firms in the least central areas make more use of the applied R&D sector (sectoral research institutes and consultants).
3. Characteristic of central areas of Norway - and also of those areas where manufacturing is of great importance to the business structure - is that the innovation process is directed towards more radical innovations, i.e., the development of new products, processes and markets. In less central areas where manufacturing does not dominate business structure it appears that incremental innovations are more important, in the form of changes to existing products and processes, as well as the "importing" and altering of external innovations.
4. Firms in peripheral areas consider economic factors to be more important obstacles to innovation than firms in other areas. These obstacles largely concern the possibilities for financing innovation activities. Further, firms in less central areas consider lack of qualified personnel and lack of information on technology and markets to be greater obstacles to innovation than firms elsewhere.

The conclusion that city-firms employ more R&D in the innovation process, and concentrate more on radical innovations, concurs with other empirical results which show that cities can act as "innovation-centres" in Norway. Firstly, new and technologically advanced manufacturing sectors generally arise in city areas, in particularly the Oslo area. Secondly, the labour force in city areas is overall more highly educated than in the rest of the country, even when figures are adjusted to account for the fact that cities have relatively large numbers of employees in sectors with high levels of education. Thirdly, the R&D sector is to a large degree concentrated around Norway's university cities.

The network-based model is most productive

The results of this report clearly show that the network-based innovation model most accurately describes how innovative activity took place in Norwegian manufacturing during the early 1990s. This model anticipates a relatively even spread of innovative activity. Further the network-based model concurs with other, more general observations concerning the innovation process: 1) the innovation process incorporates many activities in addition to "pure" R&D, 2) firms innovate in co-operation with many other firms and institutions, in particular with customers and suppliers, 3) firms appear to emphasise incremental innovations in particular.

Although the network based model is most useful when explaining the innovative activity of Norwegian manufacturing in the early 1990s, we should not ignore the linear model altogether. The linear model appears to be valid for those central areas of Norway where firms employ most R&D in the innovation process and invest more in radical innovations. To some degree this reflects the dominance in central areas of large firms and firms in R&D intensive sectors.

Implications for regional innovation policy

Norwegian regional innovation policy has until now largely been based on the linear innovation model rather than on the network based model, inasmuch as policy has to a great extent concentrated on transmitting R&D-competence to small and medium-sized firms in the districts. There is no doubt that this is an important aspect of regional innovation policy. However, this policy must be supplemented by other methods when we take the network based model into account.

The network based model understands innovative activity as an interactive process between firms and their environment, and consequently the concept *innovation systems* becomes important. Traditional small and medium-sized firms form a particularly important target group for regional innovation policy, and *regional innovation systems* are of particular importance to these firms. Often these firms lack the competence and resources to carry out their own R&D, they may experience problems in identifying their needs within the innovation process and lack the opportunity to take part in large networks. Large firms - but also resourceful small firms - are more able to link with national and international R&D and innovation networks without external help.

This report charts geographic variations in innovative activity in order to provide a background for the formulation of a regional innovation policy that suits local conditions. On the basis of this we have identified three area types where innovative activity takes place in different ways. The consequences for regional innovation policy are discussed in relation to each of the three area types.

The first area type to be considered is *non-central areas with little manufacturing*, where we find low levels of innovative activity in manufacturing compared with national levels. An approach which builds on establishment of regional innovation systems is often unsuited to these areas, due to the weak manufacturing base. There is often a dearth of local companies for firms to co-operate with, and we generally find that there are few service-companies or research institutes in the area.

The STEP-Group’s study of innovation in Finnmark county (largely an area 1 type) similarly showed that the regional innovation system is poorly developed. Innovative firms in Finnmark depend on national and international innovation systems. Concrete proposals to strengthen the innovative capacity of manufacturing firms in Finnmark included the strengthening of the regional college and research system. Regional institutions should, further, function as intermediaries. Research institutes and also regional authorities must assist firms in Finnmark to forge links with relevant national and international research milieus, as well as with other firms.

The methods proposed to strengthen the education and research systems in Finnmark, and to increase the role of regional institutions as intermediaries, bear many similarities to the way technology and transfer centres in Germany and France function. These centres provide technological services for small and medium-sized firms. These services are not necessarily based upon the latest research results, but provide technological information which has relevance for - and is new to - the companies. Finnmark lacks institutions that can run this kind of centre, inasmuch as there is no technical college in the county. May be a stronger co-operation between the fishing industry in Finnmark and the Norwegian Institute of Fisheries and Aquaculture Ltd, situated in Tromsø in the nearby county, could strengthen the innovation system in Finnmark.

In addition to a lack of technological and market information, manufacturing firms in Finnmark consider a lack of capital, and problems in attracting qualified personnel, to be important obstacles to innovation. There is scope to address these problems through traditional methods through the Norwegian Industrial and Regional Development Fund (SND), the Innovation and New Technology Programme for Northern Norway (the NT Programme) and placements for economists and engineers.

The second area type to be considered is *non-central areas with manufacturing*. Conditions here are better suited to the establishment of regional innovation systems, in particular in those areas where we find several firms within the same production system. The STEP-Group study of innovation in Møre og Romsdal, a county with several substantial manufacturing milieus, found a lack of regional innovation systems. There are several innovative manufacturing firms in the county, but firms largely innovate in isolation, using the skills and capital that already exist within the firm.

What prevents the manufacturing milieus in Møre og Romsdal from being characterised as regional innovation systems is the lack of co-operation between firms, and between firms and R&D and educational institutions. The greatest obstacle to innovation is considered to be the risk of rapid imitation by other firms. As Møre og Romsdal is an area with many small firms within traditional manufacturing sectors, there also seem to be a need to establish technology centres in order to increase innovation activities. It would appear that the establishment of new centres, or the reorganisation of existing institutions, is required, as these are considered to have little relevance for innovation activities by most firms.

An important task for any technology centre in Møre og Romsdal would be to increase co-operation on innovation between local firms. This kind of co-operation is poorly developed, although in particular "user-producer" co-operation is regarded as being important to the innovation process. Further it is particularly important that technology centres in Møre og Romsdal are not too heavily oriented towards R&D. Firms in the county largely carry out incremental innovations, and require assistance in the technological upgrading of products and processes, and in trial production and production start-up. Naturally some firms will also require advanced R&D services, which it is likely they will have the resources and skills required to obtain from national and international R&D institutions.

As in Finnmark, firms in Møre og Romsdal experience problems with acquiring capital to finance innovation activities, and in attracting skilled personnel. Thus in this area too there is a need for traditional policy methods such as providing capital and support for the training and recruitment of labour.

The third area type comprises *central regions with all round industrial structure*, where relatively high levels of innovative activity are found. When the basis of policy rests on a perspective of "comprehensive regional policy", innovation policy should here concentrate on those fields where these areas are advanced in relation to the rest of the country. As the majority of R&D institutions in Norway are found in central areas it may be important to stimulate contact between such institutions and business.

Establishing science parks can increase contact between research and business. Here research institutes, universities and companies are located together, in order to increase synergy through daily contact. Technology parks differ from the technology centres discussed above in connection with area types 1 and 2. Technology parks are concerned with the commercialisation of research results, whilst technology centres are concerned with making established technologies accessible to small and medium-sized firms.

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1. Introduction

This report uses the results of a national survey of Norwegian manufacturing innovation to chart geographical variations in innovative activity in Norway. There are many reasons to carry out this type of mapping. Firstly, innovation and technological change are central to economic growth in developed countries. Secondly, innovation is largely a territorial phenomenon, that is to say, the innovation process is in part based on resources that are location-specific, i.e. resources which are tied to particular places and cannot be copied or reproduced elsewhere. Thirdly, innovation occurs differently in different regions, depending on the firm and industry structure, as well as on varying social and cultural conditions. It is, therefore, essential to understand how the innovation process takes place, in order to develop a regional innovation policy tailored to suit varying local conditions.

2. Two models of regional innovation development

This chapter presents the theoretical background to the empirical analyses of the report. Two different models for innovation are discussed. The first is based on the linear innovation model, whilst the second is based on the understanding of innovation as a process of interaction between firms and their environment. The models have different understandings of how innovation takes place, as well as of *where* (in which geographical areas) innovative activity takes place. Further, the models have very different implications for regional innovation policy.

One of the aims of the empirical analyses of this report is to establish which of these models is most useful when describing geographical variations in innovative activity in Norwegian manufacturing. That is to say, which model and what concepts allow the greatest insight into and best describe the innovation process in Norwegian regions. The most useful model should firm the basis for developing a regional innovation policy in Norway. However, the two models are not necessarily mutually exclusive, but may in fact supplement each other. One or the other may be best suited to describe developments in particular areas or industrial sectors, in which case it will be important to limit the use of each model to those areas and sectors.

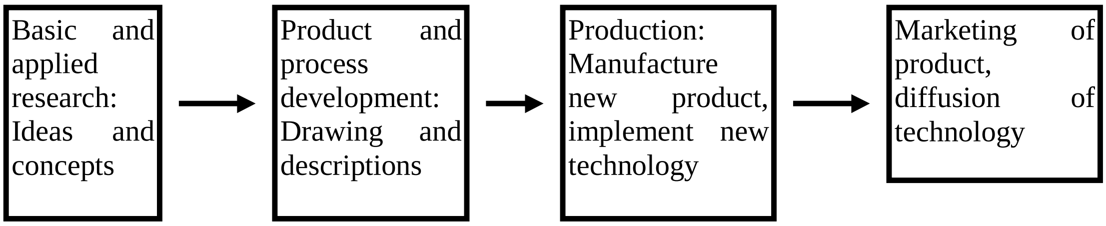
How the innovation process takes place in Norwegian regions is an empirical question, and we will address various aspects of this question here. We regard the two models presented in this chapter as possible tools for interpreting and explaining data on regional variations in the innovation process. Thus the question of which model is most useful makes up an important component of this report.

2.1 The linear innovation model and regional, hierarchical division of labour

The first model of regional innovation we examine is based on the linear innovation model. The linear innovation model presents different stages in the development of an innovation (Figure 1.1). Put simply it is assumed that the ideas and concepts for innovation originate in a research institute or the research department of a large company. In the next stage drawings or descriptions are developed into a new product or production process by the development department. Subsequently the engineers in the production department take over the “relay baton”, and establish how to manufacture a new product or implement a new production process. Finally, it is the responsibility of the marketing department to sell any new product that arises from the innovation process.

In the linear model, the innovation process is characterised by specialisation. Research and development within firms is separated from production, and there is little two-way communication between the two types of activity.

Figure 1.1: The linear model of innovation (after Malcki 1991)



Geographical consequences

The division of labour between departments and groups of employees within firms in the linear model of innovation is also reflected in a *geographical division of labour*. The classic example of geographic consequences of the linear model is innovative activity in multi-located firms. In the ideal model such firms locate the majority of research and development activities, as well as other parts of the innovation process, in the more central regions of the country close to universities and other R&D institutions, where there is also easy access to a highly educated work force (Henry et. Al. 1995). Firms locate much of the standardised production to branches in peripheral areas or to countries with low labour costs. Branch plants mainly produce to specification, and they largely employ unskilled labour. These firms are not involved in innovative activity to any great extent, and “the possibility of local learning is precluded” (Dicken et. al. 1994: 30).

The linear innovation model anticipates that innovations are first and foremost developed internally, within large companies (Tödtling 1994). However the model can also display where different kinds of small and medium sized firms develop. It is anticipated that small innovative firms are found in central areas. It is in central areas that small firms find the research and development competence necessary to innovate, as it is in general in these areas that large firms have their R&D department, and it is here that most universities, colleges and public R&D institutes are found. Thus in the linear innovation model we expect to find much of the innovative activity taking place in central areas.

2.2 The network-based innovation model and regional mosaic

The second innovation model is based on criticisms of the linear innovation model, which argue that the latter does not accurately portray the way in which innovative activity takes place (Smith 1994). In the second model, innovation is understood as a *non-linear process*, involving activities other than formal R&D. These activities include product design, trial production and production start-up, the purchase of patents and licenses, market research and investments - in new machinery, for instance (Nås et. al. 1994). However the importance of R&D varies between different sectors. In the pharmaceutical sector R&D accounted for over 80% of innovation costs in 1992, whilst printing and publishing had the lowest costs associated with R&D, at less than 10%.

Another central point to the criticisms of the linear innovation model is that innovation is a process of *interactive learning*. All the various departments of a firm participate in the innovation process, and firms co-operate with other firms. Steady changes to products and processes demand close co-operation between all employees, and cannot be carried out by specialised R&D personnel alone. Further, innovations are frequently developed in close co-operation with clients, in order to address specific problems they have, or in association with suppliers of machinery, in order to solve problems in the production process. Small firms and networks of firms can also play an important role in the innovation process (Tödtling 1994). On the whole, "collective entrepreneurship" is seen as more important in this model than in the linear innovation model, and the role of individual entrepreneurs is seen as more limited.

A third point is that the innovation process is understood not only as a technical but also a *social* process. Innovations demand extended and close co-operation between people, both within firms and other institutions, and between them. This kind of co-operation is likely to require mutual trust and understanding. Further, innovation and technological change are created from already existing knowledge and skills, and develop along specific paths. This knowledge and skills are found partly in local institutions and business milieus, which can lead to the development of regional paths for innovation development (Tödtling 1994).

Geographical consequences

In this more complex, network-based model, innovative activity occurs in a different manner - and to some extent in different geographic areas - than in the linear model. Innovative activity is presumed to be widespread, and regional conditions are seen as having greater bearing on the innovation process. Regional conditions are seen as "contributor[s] to the creation of technology" (Courlet and Soulage, 1995: 293)[1].

The increased emphasis on regional factors and the geographical spread of innovative activity reflect two important aspects of the second innovation model. Firstly, innovation is presumed to take place within networks of firms and institutions, and secondly, incremental innovations are given greater significance.

Through *network*-based co-operation, firms are able to specialise in different parts of a production process. Specialisation increases the possibility of building-up competence, which in turn encourages innovative activity. Network-based innovation is encouraged when firms are located close to each other. Prolonged, direct and close co-operation between different actors is necessary to the development of complex and specialised products or processes, and this is achieved most easily when there are short distances between firms.

Proximity ensures that people are able to meet frequently and quickly, and that actors have similar cultural backgrounds. Extensive co-operation between firms requires a degree of loyalty, as well as mutual respect and trust, which develop over time (Lundvall and Johnson 1995). Mutual trust is encouraged, and uncertainties diminished, when actors are familiar with the same informal rules and practices of co-operation. These informal rules and institutions are often the result of long historical processes in specific areas, and can therefore be specific to certain

[1] Similarly Tödtling points to "a stronger role for 'place' in... the innovation process" (1994: 68-9)

geographical areas. These are *untraded interdependencies* between actors (Storper 1995). This refers to the fact that mutual trust cannot be purchased, but is essential to co-operation that leads to technological and organisational learning. Untraded interdependencies is equivalent to Maillat's (1995) term *atmospheric externalities*, which originate in a common technological culture and a highly mobile labour market. This facilitates the exchange of knowledge and makes it easier also to establish contacts and exchange information between persons and firms in an area.

When smaller and incremental innovations are accorded greater importance, knowledge and learning become important factors in the innovation process. Lundvall and Johnson (1995) thus see knowledge as the fundamental resource of the economy and learning as the most important process. "The economy as a whole... is 'learning by doing' and 'learning by using'" (Lundvall and Johnson 1995: 26).

To a great extent, knowledge is embodied in machines and components, or can be sold in the form of patents and complete plants. However, much important knowledge remains unspoken or *tacit*, that is, it cannot be communicated through speech or writing. People possess this knowledge, and pass it on through informal teaching at the workplace and in the local community. "Important elements of tacit knowledge are collective rather than individual" (Lundvall and Johnson 1995: 30). Often these skills have been built up through many years of experience with a particular production process in an area. These skills include the ability to introduce frequent, small changes to products and processes, to solve production problems, as well as to develop efficient ways of producing new products. These kinds of incremental innovation are usually developed within the production process, by engineers, technicians and other personnel (Freeman 1995).

In those cases where incremental innovations are considered decisive to firms' competitiveness and survival, the significance of tacit and local knowledge increases. Formal R&D is considered to be less important than in the linear innovation model, where it is thought that innovations are largely developed in the R&D departments of large companies. However, R&D capabilities and systematic research and development remain decisive to radical innovation, although in these cases too, contact with clients and suppliers remains vitally important[2].

The specific regional conditions which can function as a platform for innovative activity are thus 1) the presence of collective tacit knowledge, often developed through long-term experience with a production process, but also R&D capabilities, and 2) the presence of mutual trust, which encourages co-operation on innovation, both within and between firms and institutions. The network-based innovation model would thus lead us to expect innovative activity in the form of incremental innovations particularly in those areas where there is a history of experience within particular sectors, and a tradition of co-operation between firms. Rather than a centre-periphery pattern, as in the linear innovation model, the network-based model leads us to expect a "mosaic-pattern", where both central and peripheral areas may stand out with high levels of innovative activity.

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[2] Radical innovations are new products and processes, such as colour television and numerically controlled (NC) machines (Freeman and Peres 1986). Incremental innovations concern the improvement of existing products and processes, and takes place more or less continuously.

2.3 Central features of the two innovation models

The two innovation models are ideal types which cannot be found in any "pure" form in reality. The models outline typical features of the innovation process as it takes place during different periods and within different firms and sectors (Table 2.1).

The linear innovation model is often linked to the Fordist form of production (Andreasen et. al. 1995), or was at least an important reference point to understand innovative activity in Fordism (Henry et. al. 1995). Fordism refers to the methods of mass production introduced by Henry Ford to his car factories during the 1920s and 30s. The concept is used to characterise the economies, and manufacturing production forms, of industrialised Western countries from around 1920 until the mid 1970s. The organisation of production aimed at mass production of standard products in order to achieve economy of scale. Individual tasks were heavily specialised, and price competition dominated (Andreasen et. al. 1995). The economy was dominated by sectors such as the car industry, manufacture of consumer durables and capital goods[3].

The network-based innovation model is often associated with post-Fordism. The term "post-Fordism" is used to describe changes in the economy and in society at large after the Fordist crisis at the end of the 1960s (Amin 1994)[4]. The industrialised countries in Western Europe and North America experienced a decline in profits due to reduced growth in productivity, rising real wages and increased competition from Japan and the newly industrialised countries. The weaknesses of mass production methods were revealed in this situation, in the form of inflexibility in the face of fluctuating markets, and in the form of low profits when production equipment was suboptimally used.

[3] By no means did the Fordist method of production extend to include all areas of economic life or even the entire manufacturing sector. Even during its heyday in the 1950s and 60s, only a small part of manufacturing was characterised by standardised mass production. This is particularly true for Norway, where there are few typically Fordist sectors such as the car industry and durable consumer goods. However, according to Jessop (1992) a nation does not require the presence of many mass-producing firms in order to be characterised as Fordist, although it must create sufficient income from exports to finance the import of mass produced goods. Further the state must play a key role in the creation of demand and must contribute to mass consumption. Further, there must be established a connection between wage growth and growth in productivity and inflation. These requirements are satisfied in Norway's case.

[4] There is general agreement about the characteristics of Fordism, but significant debate concerning the features of the next phase of capitalism. There have been no sharp breaks in development - mass markets and mass production continue to be important to some sectors.

Table 2.1: Characteristics of two innovation models

	Linear innovation model	**Network-based innovation model**
Important actors	Large firms and the R&D sector	Both small and large firms, the R&D sector, clients, suppliers, technical colleges, public authorities
Important inputs in the innovation process	R&D	R&D, market information, technical competence, informal practical knowledge
Geographical consequences	Most innovative activity (R&D) in central areas	Innovation activity more geographical widespread, but especially occurring in manufacturing milieus
Typical industrial sectors	Fordist manufacturing	Flexible industrial sectors
Implications for regional policy	Promote R&D in less central areas	Develop regional innovation systems, and linking firms to wider innovation systems

Manufacturing in Western industrialised countries adjusted to the crisis-tendencies in various ways. Firstly, firms relocated production to countries with low wage levels, often termed a neo-Fordist solution. Secondly, a reorganisation of Fordist mass production has taken place, through automation, increased subcontracting, and through new methods of internal organisation (Storper and Scott 1990). Thirdly, more flexible production methods have emerged, particularly in the following three sectors: craft-dominated and design-intensive industries (for example the production of clothes, shoes, furniture, ceramics, musical instruments etc.), high-tech manufacturing (particularly electronics and computer industry), and producer services (the consultancy sector).

We are thus not talking about a clean break with Fordist methods of production. Elements of the latter are retained, whilst new elements are added. Consequently, the linear innovation model may continue to be useful for understanding the innovation process in some sectors, at least to the degree to which the linear model gives an accurate picture of innovation in "Fordist" firms.

The third type of adjustment listed above (more flexible production methods) is linked to post-Fordism. Most researchers consider flexible production methods as a feature which identifies the new form of production (Jessop 1992). This is based on the use of flexible computer-controlled production equipment, a flexible work force[5]and flexible organisation through a network of specialised units, as well as increased use of consultants, specialists and different co-operation solutions. The network-based innovation model provides the most accurate picture of innovative activity in the flexible business sectors.

Implications for regional policy

The linear innovation model is often used as the basis for regional technology and innovation policy (Malecki 1991, Smith 1994). Indeed, certain policy-implications

[5] Skilled labour is seen as an important competitive asset in post-Fordism, in contrast to Fordism, where labour was seen as a cost to be minimised (Andreasen et.al. 1995)

can be drawn from this model, i.e., we must increase the quality and extent of research and development, as this forms the basis for innovation. Regional innovation policy would thus entail building up R&D in the regions, as has been done in Norway through the development of regional colleges and research institutes[6].

Regional innovation policy must partly take other forms if the network-based model is the basis for policy-making. As discussed above, in this model innovative activity is understood as an interactive process between firms and their environment. Firms innovate in co-operation with other firms and institutions, such as clients, suppliers, universities, colleges and R&D institutes. Further, the innovation process is conceived of as a non-linear process that involves activities other than formal R&D. The uncodified, practical skills of an areas' work force - skills that have developed through long experience with a particular production - will be an important factor in the innovation process. In addition, innovation is encouraged by informal institutions which contribute to trust-based co-operation between actors[7].

In view of the network-based innovation model, an important aim of regional innovation policy must be the creation of regional innovation systems, incorporating the regionally located institutions which determine the innovation capacity of a region (Isaksen 1995). These institutions include; a) firms, especially those taking part in the innovation process, b) universities, colleges and other R&D institutions, c) vocational technical colleges and other forms of vocational training and d) regional authorities.

There is, however, no single regional innovation policy which can be applied to all areas. The innovation process occurs very differently in different firms. Regional innovation policy must be tailored to suit both the varying industry and firm structures, as well as the socio-cultural conditions of different areas. The conditions in some regions may be suited to the development of regional innovation systems, while in other areas it may be more natural to link firms to national and international innovation systems. Policy must suit local/regional needs. A similar conclusion is drawn by an EU study, which states "Public policies to promote the innovative capacities of localities (regions, cities) will have to be adapted to meet the needs of very different systems" (Hingel 1993: 33).

Once we recognise that innovation policy must take different forms, we need to establish the ways in which innovation does take place in different firms and regions in order to develop regional innovation policy suited to local conditions. Accordingly this report will first chart how innovative activity occurs in different Norwegian regions, secondly we will analyse which of the two models best explains innovative activity in different geographic areas, and finally we will discuss the implications these findings have for regional innovation policy.

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[6] These developments do however have other aims in addition to the development of the regional economies.

[7] Informal institutions are defined as the collection of habits, practices, norms and laws, which regulate interpersonal relationships and thus shape co-operation and learning (Lundvall and Johnson 1995).

3. The data and main questions

This chapter briefly outlines the data material used in the empirical analyses and covers the questions to be answered.

The starting point for the analyses of the report is the Community Innovation Survey for Norway, carried out by Statistics Norway in 1993. This survey investigated innovative activity in Norwegian manufacturing. The results have previously been analysed and presented (Nås et. al. 1994), although for Norway as a whole. In contrast we will here use the data to describe aspects of the *geographic dimension* of innovative activity in Norwegian manufacturing.

The survey collected background information on Norwegian firms in addition to a series of data on the innovation process. This report uses two main types of data from the national survey; firstly, data concerning the extent of innovative activity, secondly data on different aspects of carrying out innovative activity.

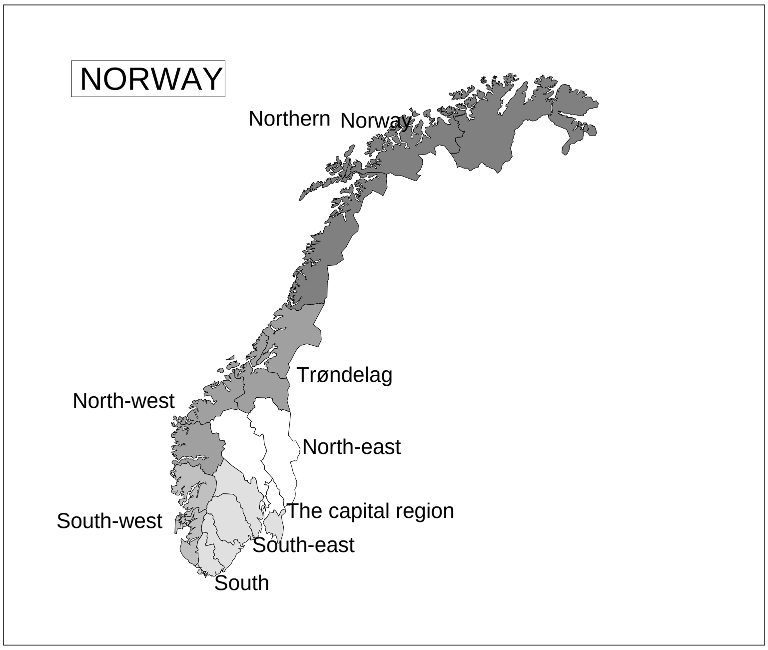
The national survey took the form of postal questionnaires to a representative selection of Norwegian manufacturing firms. Selection was made randomly from different categories based on firm size. The study had a 52% response rate, in all 986 firms. The response rate was distributed relatively evenly across the size-categories.

The original selection process did not attempt to select a geographically spread selection of firms, yet we find that firms are fairly evenly distributed across parts of the country (Table 3.1) [8]. The south-east is over-represented, while some - more peripheral - parts of the country have a lower share of firms in the innovation survey compared with their share of all firms in manufacturing and mining[9].

[8] Each part of the country in table 3.1 and elsewhere in the report includes two counties or more, as shown in map1. The capital region includes Oslo county as well as the surrounding Akershus county. The north-east contains the two more rural counties of Hedmark and Oppland, which are the only counties in Norway not bordering the sea. The south-east contains the counties along the Oslo fjord with a more or less traditional manufacturing base, namely Østfold, Buskerud, Vestfold and Telemark. The south contains the two most southern counties, Aust-Agder and Vest-Agder. The south-west includes the counties of Roagaland and Hordaland with the great cities of Stavanger and Bergen, and also the centre of the petroleum activity in the North Sea. The North-west contains the two more peripheral counties of Sogn og Fjordane og Møre og Romsdal, the last with some traditional manufacturing areas. Trøndelag contains the county of Sør-Trøndelag with the large city of Trondheim and the more rural county of Nord-Trøndelag. Northern Norway contains the three most northern counties of Nordland, Troms and Finnmark with a dominance in the fishing industry.

[9] This includes especially the north-east.

Map 1: The location of parts of the country in Norway



The regional unevenness in distribution is likely due to the fact that the survey has a greater rate of coverage for large firms than small ones. The survey includes over half of all Norwegian manufacturing and mining firms with more than 100 employees, but only 12% of firms with fewer than 20 employees (Nås et. al. 1994). This unevenness in the coverage of size-categories leads to uneven coverage of geographical areas. As there are relatively greater numbers of large firms in central areas, these areas are likely to be somewhat over-represented in the national study. In contrast, peripheral areas may be somewhat under-represented.

Proportions of employees in the different parts of the country are also unevenly distributed amongst the survey respondents. The capital region and the south-west have approximately 10 per cent point more employees in the response-group than the average for all firms in manufacturing and mining (Table 3.1). This underlines the fact that these areas contain relatively more large companies.

In the analyses presented in this report each firm is represented equally, irrespective of size. For example, we map the share of innovative firms for different areas. In such cases, it will not matter if a firm has 2 employees or 200. Thus the uneven distribution of number of employees will have no direct bearing on the results. We are here interested in the geographical spread of firms, and the firms in the response group are fairly "correctly" distributed between the different parts of the country.

Table 3.1: Share of firms and employees in different parts of the country

Parts of the country	Share of firms in manufacturing and mining in 1992	Share of employees in manufacturing and mining in 1992	Share of firms in the Innovation Survey	Share of employees in the Innovation Survey
The capital region	17,2	16,5	15,8	25,3
North-east	9,0	7,4	7,1	3,5
South- east	22,2	22,4	22,7	18,2
South	6,2	6,0	8,5	4,5
South-west	17,4	23,5	18,5	29,5
North west	11,0	10,2	10,6	5,8
Trøndelag	8,1	6,9	7,6	7,2
Northern Norway	8,9	7,0	9,2	6,0
Norway	100,0	100,0	100,0	100,0

Source: Manufacturing Statistics 1992 and the Community Innovation Survey

3.1 Main questions

The questions we address in the report reflect what it is possible to analyse on the basis of the national innovation survey. However, we also consider issues important to any discussion of regional innovation policy. The main questions of this report are:

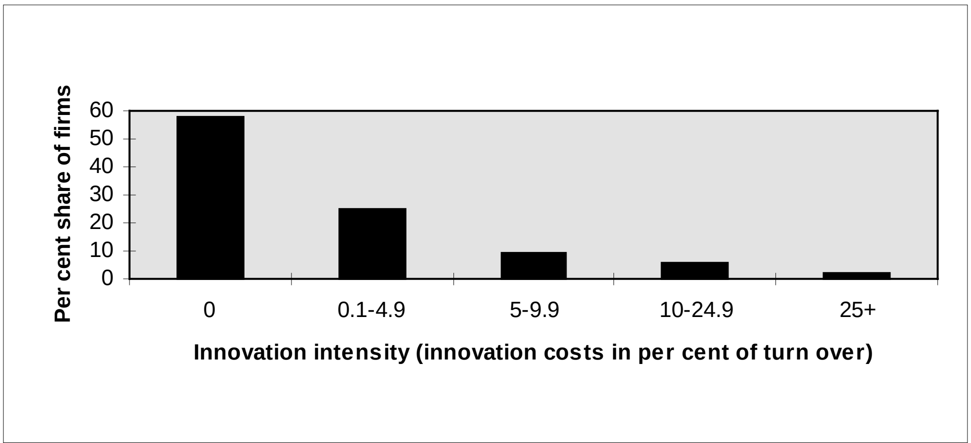
1. To what extent does the level of innovative activity vary between geographical areas in Norway? Which areas display the highest levels of innovative activity, and which areas have the lowest levels?
2. How does the innovation process occur in different areas?
3. Which of the two innovation models presented in Chapter 2 allows the greatest insight into the geographical variations in the innovative activity of Norwegian manufacturing?
4. How should regional innovation policy be developed in different types of area?

4. Geographical variations in innovative activity

In this chapter we examine the geographical variations in innovative activity in Norwegian manufacturing with the help of two indicators; 1) the total innovation costs of firms in 1992 and 2) the share of sales accounted for by products that are new or were significantly altered during the three-year period 1990-92. The first indicator gives a measure of the innovation *inputs* of firms, measuring the degree to which firms invest in innovation. The second indicator provides us with a measure of the *results* of innovative activity.

The national innovation survey incorporates responses from almost 1 000 firms. Almost 60% of firms that responded to the question on innovation costs reported no such costs for 1992 (Figure 4.1)[10]. Further, a large share of those firms that did report costs associated with innovation recorded low outlays. Figure 4.1 shows the innovation intensity of firms, calculated as total innovation costs as a percentage of firms' turnover. Three-quarters of the firms had innovation intensities lower than 5.0, which means that their total innovation costs made up less than five per cent of their turnover in 1992. 19 firms (2%) had innovation intensities greater than 25.

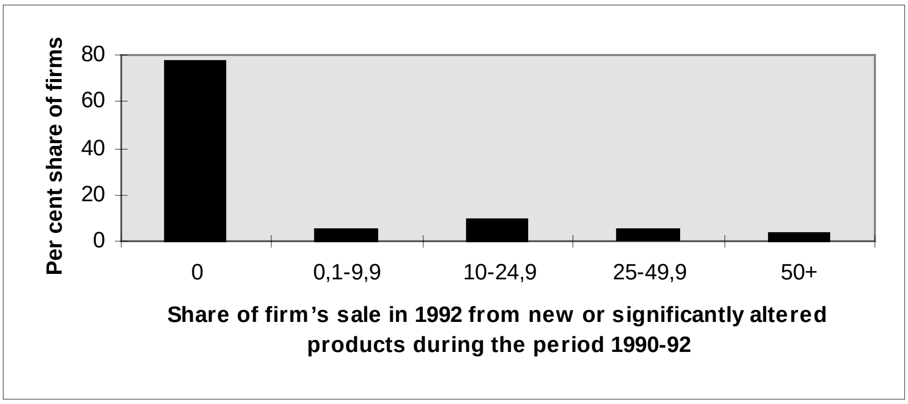
Figure 4.1: Share of firms by innovation intensity



The share of innovative firms is further reduced when we measure the results of innovative activity, namely the share of turnover accounted for by new or significantly altered products. In 1992, 23% of the firms that responded had products that had been developed or significantly altered during the three-year period 1990-92. Thus the overwhelming majority of firms were non-innovative according to this indicator (Figure 4.2).

[10] The total innovation costs in Figure 4.1 cover costs associated with the following activities; 1) research and development, 2) product design, 3) trial production and production start-up, 4) the purchase of products and licenses, 5) market analyses (excluding introduction costs), 6) other operating costs associated with innovation, and 7) investment costs (machinery, equipment etc.) in connection with product and process innovations.

Figure 4.2: Share of firms with new or significantly altered products in sale



4.1 Innovative firms in parts of the country and the counties

The percentage of innovative firms varies greatly between different parts of the country. With some exceptions, Table 4.1 shows us a basic centre-periphery pattern. Looking first at the share of firms recording innovation costs, we find that this is greatest in Trøndelag, the capital region and south-east. The north-west and Northern Norway clearly have the smallest shares. The picture changes somewhat when we look at firms with high innovation costs (where innovation costs account for 10% or more of turnover). There were only 73 such firms in the survey. The south-east and south-west had the largest number of such firms, with Northern Norway having fewest.

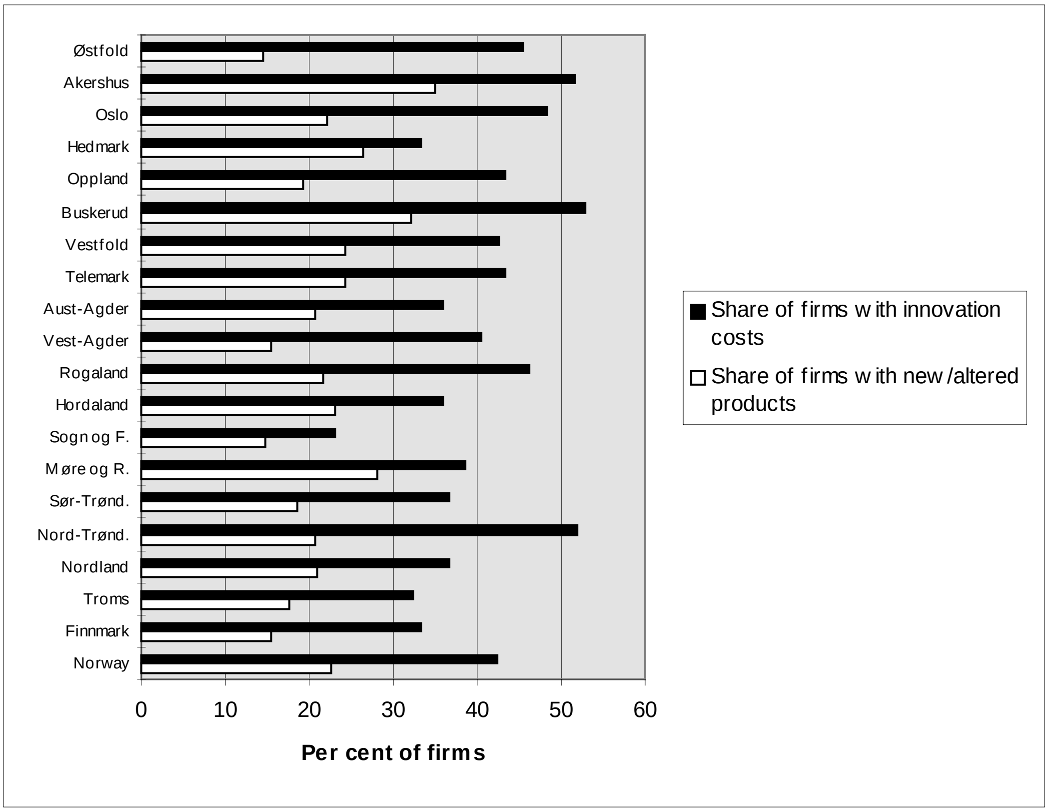
Table 4.1: Share of innovative firms in different parts of the country in 1992

Parts of the country	Number of firms*	Share of firms with innovation costs	Share of firms with large innovation costs**	Share of firms with new/altered products ***
The capital region	151	49,7	7,3	27,2
North-east	66	37,8	6,1	23,2
South-east	210	46,2	9,5	23,0
South	77	39,0	5,2	17,3
South-west	175	41,1	9,7	22,3
North-west	96	34,4	6,3	24,5
Trøndelag	58	50,0	5,2	19,4
Northern Norway	84	34,5	3,4	18,9
Norway	926	42,4	7,9	22,9

* Refers to number of firms with innovation costs.
** Firms where innovation costs amount to at least 10% of turn over .
*** Share of firms with new or significantly altered products during the period 1990-92 in sale.

Figure 4.3 shows the share of firms recording innovation costs for each of the counties[11]. The figure confirms the impression given by Table 4.1 of a basic centre-periphery pattern with some exceptions. The counties near the Oslo-fjord (Østfold, Oslo, Akershus and Buskerud) have high levels of innovative firms. Further, Rogaland has a greater share of innovative firms than the national average, whilst more peripheral counties such as Hedmark, Sogn og Fjordane, Troms and Finnmark have the smallest share of firms with innovation costs. The main exception to the centre-periphery pattern is Nord-Trøndelag, which has a large share of innovative firms. The large share displayed for the Trøndelag region as a whole is thus due to the figures for the more rural Nord-Trøndelag, not Sør- Trøndelag with the large city of Trondheim.

Figure 4.3: Share of innovative firms in the counties in 1992



When we examine the rates for the second indicator, that is, the share of firms selling new or significantly altered products, we find that the capital region has the highest rate of innovative firms (Table 4.1). The north-west rank second amongst the parts of the country. Figure 4.3 displays that the relatively high rates in these two areas are due to high figures in the counties Akershus, surrounding the capital, and Møre og Romsdal, with a relatively large number of manufacturing jobs, respectively. Oslo has a rate equal to the average for the country as a whole, while Sogn og Fjordane in

[11] County-level figures must be interpreted cautiously as the number of firms is low for some counties, increasing the chances of coincidental fluctuation. For example the county Finnmark has only 12 firms included in the innovation survey.

the north-east a clearly lower rate. Møre og Romsdal thus has a lower rate of firms with innovation costs than the country on average, but a higher share of firms with new or significantly altered products.

Many of the other counties in Eastern Norway, as well as Rogaland and Hordaland in the south-west have above average or average shares of firms with new or significantly altered products. Østfold, Vest-Agder, Sogn og Fjordane and Finnmark, with traditional manufacturing industries or peripheral location, display the lowest values according to this indicator.

4.2 Innovative firms according to area-types and commune categories

Parts of the country and counties are heterogeneous entities, incorporating both urban and rural areas. We have therefore examined geographical variations with the aid of other area categorisations which emphasise urban-rural differences. Table 4.2 shows the situation in five different types of area[12]. City centres and city surroundings have the highest shares of firms with innovation costs. However, the rural areas alone are distinguished for having a particularly low share. Smaller towns have high levels of firms with innovation costs compared to the average for the country as a whole, and this area type also has the highest level of firms with large innovation costs compared to all other area types. Thus we find that there is an even spread of innovative firms throughout all area types, with the exception of the most peripheral areas. However we must underline that firms with innovation costs are also to be found in the most peripheral parts of Norway.

The same centre-periphery pattern emerges when we chart the share of firms with new or significantly altered products according to area type (Table 4.2). City surroundings have the highest share, with city centres in second place. Rural areas have the lowest score according to this indicator also.

[12] The area types in Table 4.2 have been determined with the assistance of Statistic Norway's classification of communes according to centrality in 1990. City centres and city surroundings have "centrality code" 3. These are communes incorporating settled areas with centrality code 3, or communes within 75 minutes travelling distance (90 minutes for Oslo) to the centre of such settled areas. Level 3 areas normally have populations exceeding 50 000 and function as centres in a part of the country. Six settled areas came under this classification in 1990: Oslo, Kristiansand, Stavanger, Bergen, Trondheim and Tromsø. These six communes make up "city centres" in Table 4.2, whilst the remaining communes with centrality level 3 make up "city surroundings". "Medium sized towns" is made up of all communes with level 2 centrality. These are communes that incorporate a settled area with a centrality code 2, or that lie within 60 minutes travelling distance from the centre of such an area. Settled areas with level 2 centrality should normally have populations of between 15 000 and 50 000. "Smaller towns" comprise all communes with centrality code 1. These communes have a settled area of level 1, or lie within 45 minutes travel distance from the centre of such an area. Settled area of level 1 should normally have a population of between 5 000 and 15 000. Finally rural areas incorporate those communes with centrality level 0. These areas do not meet any of the requirements for levels 1, 2 or 3.

Table 4.2: Share of innovative manufacturing firms in five area-types. 1992

Area-types	Number of firms*	Number of firms with innovation costs	Number of firms with large innovation costs**	Number of firms with new/altered products***
City centres	213	45,5	9,4	23,0
City surroundings	242	46,7	9,1	27,1
Medium sized towns	251	43,4	6,7	21,8
Smaller towns	67	43,3	11,9	21,9
Rural areas	148	27,0	4,7	17,9
Norway	926	42,4	7,9	22,9

* Refers to number of firms with innovation costs.
** Firms where innovation costs amount to at least 10% of turn over .
*** Share of firms with new or significantly altered products during the period 1990-92 in sale.

A further regional classification is Statistic Norway's classification of communes according to both industrial structure and centrality (Table 4.3)[13]. A number of the commune categories have small numbers of firms, so we must be cautious about drawing firm conclusions. However, we find that the impression given from the other regional classifications is confirmed. The lowest share of firms with innovation costs is found in those communes dominated by primary industries, which are also peripheral communes. A low share of innovative firms is also found in the less centrally located communes dominated by service industries. The share is greatest in central communes, where the economy is dominated by service industries or also by manufacturing. However the "pure" manufacturing communes also have fairly high numbers of firms with innovation costs.

That the communes dominated by manufacturing have a high share of innovative firms is confirmed when we look at the share of firms with new or significantly altered products. The manufacturing communes, and the less central, combined service industries and manufacturing communes have the greatest shares. All in all Table 4.3 shows that less central areas have a reasonably high proportion of innovative firms in those commune categories where there is a significant degree of

[13] This classification is in the first instance based on the employment structure of the working population in 1990. In four of the categories the communes are dominated by one sector, namely the categories primary industry communes, manufacturing communes, the less central and central service industry communes. The primary industry communes and manufacturing communes have more employees in manufacturing goods than in the service industry. Further the primary industries and manufacturing employ more than two-thirds of the work force. In the service industry communes the service industries employ twice as many workers as manufacturing goods. The three final categories are of communes dominated by two sectors, agriculture and manufacturing, and service industry and manufacturing respectively. The central categories (central service industry communes and central, combined service and manufacturing communes) have centrality codes of 3 or 2A. This means that the communes a) includes a settled area with centrality level 3 (at least 50 000 population and a centre in a part of the country) or is within 75 minutes (90 for Oslo) travelling time from the centre of such a settled area, or b) includes a settled area with centrality code 2 (at least 15 000 population) or lies within 60 minutes travelling time from the centre of such a settled area, and at the same time being no more than 2 1/2 hours travelling time from a level 3 area (3 hours from Oslo).

manufacturing jobs (commune categories 2, 3 and 4). In contrast, less central areas with little manufacturing have extremely low rates of innovative firms. The primary industry communes and the less central service industry communes clearly have the lowest levels of firms with new or significantly altered products. It is these communes that contribute to the relatively low shares of innovative firms found in rural areas as a whole in Table 4.2.

Table 4.3: Share of innovative firms in seven commune categories. 1992

Commune categories	Number of firms*	Share of firms with innovation costs	Share of firms with large innov. costs **	Share of firms with new/altered products***
1. Primary industry communes	48	16,6	2,1	10,2
2. Combined agriculture and industry communes	50	38,0	6,0	23,5
3. Manufacturing communes	116	43,1	6,0	28,5
4. Less central, combined service and industry communes	81	40,7	12,3	28,8
5. Central, combined service and industry communes.	295	46,4	8,8	21,7
6. Less central service industry communes	59	32,2	1,7	11,1
7. Central service industry communes	273	44,7	9,5	24,5
Norway	926	42,4	7,9	22,9

* Refers to number of firms with innovation costs.
** Firms where innovation costs amount to at least 10% of turn over .
*** Share of firms with new or significantly altered products during the period 1990-92 in sale.

Finally, Table 4.4 charts the share of innovative firms in the “new industrial spaces” identified in Isaksen and Spilling (1996). These are labour market regions that are specialised towards on or more industrial sectors, that have a number of firms in the relevant sectors, and are in sectors where division of the production chain (vertical disintegration) has been possible, resulting in the creation of subcontracting systems[14]. 33 such production areas were identified in 1990. The national innovation survey provides information on 134 firms in the relevant sectors in the “new industrial spaces”., i.e., those sectors that constitute the specialisation of the area. The “new industrial spaces” displayed slightly higher shares of innovative firms than the equivalent sectors nation-wide, for both indicators used. Due to the small selection available it is not possible to draw any firm conclusions from Table 4.4, but

[14] “New industrial spaces” cover labour market areas where a) the localisation quotient is greater than 3.0 for an industrial sector, b) the sector includes more than 200 man-years in the labour market area, c) the sector has more than 10 firms in the region, and d) vertical division of the production chain is possible in these sectors. Using this categorisation 33 “new industrial spaces” were identified, with almost 47 000 man years in seven industrial sectors: textile and clothing, wood products, furniture, printing and publishing, machinery, metal products, shipbuilding and electronics/electrics.

the labour market areas termed “new industrial spaces” appear to have at least as great a share of innovative firms as the national average.

The “new industrial spaces” contains mainly communes other than the “manufacturing communes” in Table 4.3. In the manufacturing communes there are many one company towns with firms in sectors other then those dominating in “new industrial spaces”. However table 4.3 and 4.4 reveal the same tendencies, namely that areas with significant amounts of manufacturing have a share of innovative firms that is equal to or higher than the national average.

Table 4.4: Share of innovative firms in “new industrial spaces”.

	Number of firms*	Number of firms with innovation costs	Number of firms with new/altered products**
“New industrial spaces”	134	40,3	23,9
Corresponding industrial sectors nation-wide	583	39,4	21,9

* Refers to number of firms with innovation costs.
** Share of firms with new or significantly altered products during the period 1990-92 in sale.

4.3 Causes of regional variation, shift-share analysis

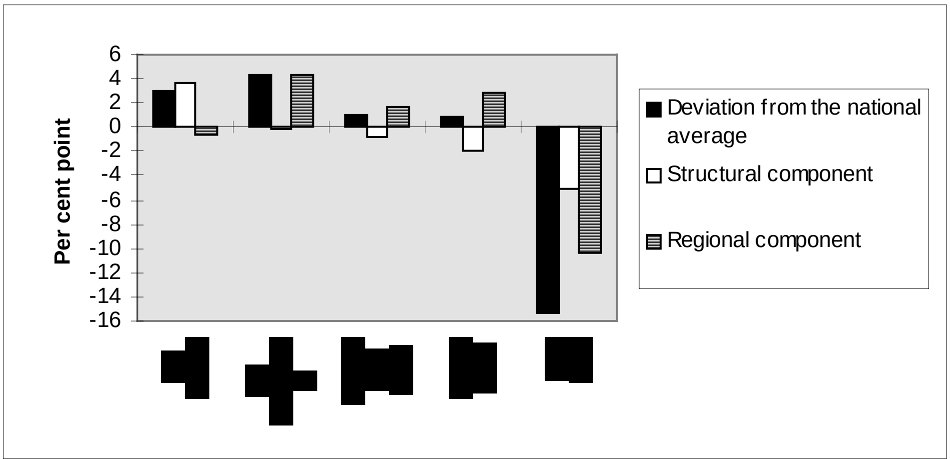
The geographical variations in the shares of innovative firms can in principal be explained by two different factors, namely the structural and regional components. The structural component refers to the different industrial and firm structures of areas. The share of innovative firms varies widely between different manufacturing sectors, and there are relatively greater numbers of innovative firms amongst large firms than small ones (Nås et. al. 1994). An area may have a high share of innovative firms because of a favourable “structure”; the area then has a relatively high number of firms in innovative industries (industries with a large share of innovative firms) and/or the area has a high number of large firms. In contrast, a low level of innovative firms may reflect the fact that an area has few firms in innovative sectors and/or many small firms.

What we call the *regional component* is a residual factor, which shows that aspect of geographical variation that cannot be attributed to differing industrial and firm structure. The regional component thus measures the geographical variations in the shares of innovative firms *within* different industries and size-categories of firms[15].

[15] This approach is in principle the same as that which can be used to explain differences in birth rates between areas (Ahnström 1979). Thus one can distinguish between the effects of differences in fertility rates (average number of children born to each woman) and the effects of differences between the age group structures of an area. A high birth rate may be due to high fertility rates; that many children are born to each woman. This would be considered a regional component. High birth rates can also reflect a favourable age structure, where an area has a large proportion of women of child-bearing age. This would be a structural component.

The starting point for calculating structural and regional components is the difference between the share of innovative firms in an area and the national average. Figure 4.4 shows the difference between the share of firms with innovation costs in the five area types, and the country as a whole (black columns). As we saw earlier (Table 4.2), the rural areas have significantly lower shares of innovative firms than the national average, whilst the four remaining area types have slightly above average shares. Using a shift-share analysis we can establish how much of the difference is due to the "structure" of the different areas (the structural component) and how much is due to greater or lesser shares of innovative firms in the individual sectors in the area types (the regional component). Industrial structure alone is taken into account when calculating the structural component in Figure 4.4[16].

Figure 4.4: Share of firms with innovation costs 1992. Shift-share analysis by industrial structure



Rural areas have an approximately 15 per cent point smaller share of firms with innovation costs than the national average. The structural component can "explain" a third (5 per cent point) of this difference (Figure 4.4). The rural areas have a negative structural component, as there is a relatively large number of firms in many industries with low levels of innovation nation-wide. This is particularly true of the food products, wood products, furniture and transport equipment industries. Further, rural areas have a significant negative regional component, which shows that the individual industrial sectors generally have fewer innovative firms in these areas than

[16] 18 sectors are used when calculating the structural component; oil extraction, mining, and 16 sectors at 2 and 3 digit level in the industrial code. The first step is to calculate a hypothetical value which shows the share of innovative firms each area-type would have if each sector in the areas had the same share of innovative firms as the national average. For each area we have multiplied the share of firms in each sector in the area with the national average share of innovative firms in that sector. The structural component is then the difference between this hypothetical value for each area-type and the overall share of innovative firms in the country. Where an area's structural component is a positive number we say that the area has a favourable industrial structure. The area thus has relatively many firms in industries with high shares of innovative firms on a national level. In contrast, areas with negative structural components will have many firms in industries with low levels of innovative firms on a national basis. Finally the regional component of area types is calculated as the difference from the national average minus the structural component for each area-type.

is the case for the nation as a whole. Thus the rural areas face a double problem; these areas have much of their manufacturing firms in sectors that are not very innovative, and they have relatively few innovative firms within the various sectors.

The smaller towns also display a negative structural component, as they have a relatively large number of firms in the same sectors as rural areas. However this negative component is outweighed by a positive regional component. On the whole smaller towns has relatively more innovative firms within the various sectors than the national average. Smaller towns thus have a somewhat greater share of innovative firms than the national average despite an unfavourable business structure.

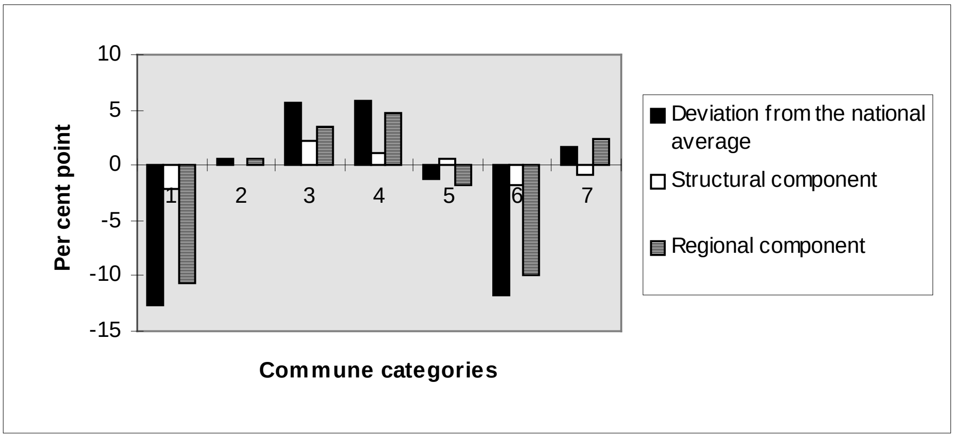
City centres are the only area type that display a positive structural component. This reflects the fact that city centres have a relatively large number of firms in innovative sectors such as oil extraction, chemicals, and machinery. City centres have a small, negative regional component, which reflects that firms in the six city-communes are not particularly innovative compared to the national average[17]. The high shares of innovative firms found in city centres thus reflects that these areas contain many firms in innovative sectors and *not* that firms are particularly innovative, when one adjusts for industry structure. However, city surroundings have a positive regional component, reflecting the relatively high number of innovative firms found within the individual sectors in these areas.

Figure 4.5 shows the results of using a different indicator (share of firms with new or significantly altered products) and a different regional classification (commune categories). We find low figures for the structural component in all the commune categories. This reflects that the commune categories contain firms in innovative and non-innovative sectors. For example, commune category 7 (central, service industry communes) shows a small negative structural component. This reflects that this category has many firms in printing and publishing, and also above average numbers of firms in textile and clothing, both of which are fairly non-innovative sectors[18]. On the other hand the central service-industry communes have a relatively large number of firms in innovative sectors such as chemicals, and electrical apparatus and materials, which contributes to a positive structural component.

[17] This is certainly the case when looking at firms with innovation costs in the response-group of almost 1 000 firms.

[18] That is to say that these industries had relatively small shares of firms in 1992 with new or significantly altered during the period 1990-92 in sale.

Figure 4.5: Share of firms with new/altered products in sale. Shift-share analysis by industrial structure



The primary industry communes (category 1) and the less-central service-industry communes (category 6) both have negative structural components. This reflects that both these categories have relatively large numbers of firms in the food industry and in the production of transport equipment, both industries with below average shares of innovative firms. However, it is first and foremost the regional component which accounts for the low share of innovative firms in categories 1 and 6. These categories have relatively small numbers of innovative firms within the individual sectors. In food products, for example, categories 1 and 6 had 13% and 9% innovative firms respectively, whilst on a national level the share of innovative firms in this sector was 19%.

Figure 4.5 reveals the relatively high number of innovative firms in commune categories 3 and 4 (manufacturing communes and less-central, combined service-industry and manufacturing communes). These two categories possess favourable industrial structures and also positive regional components.

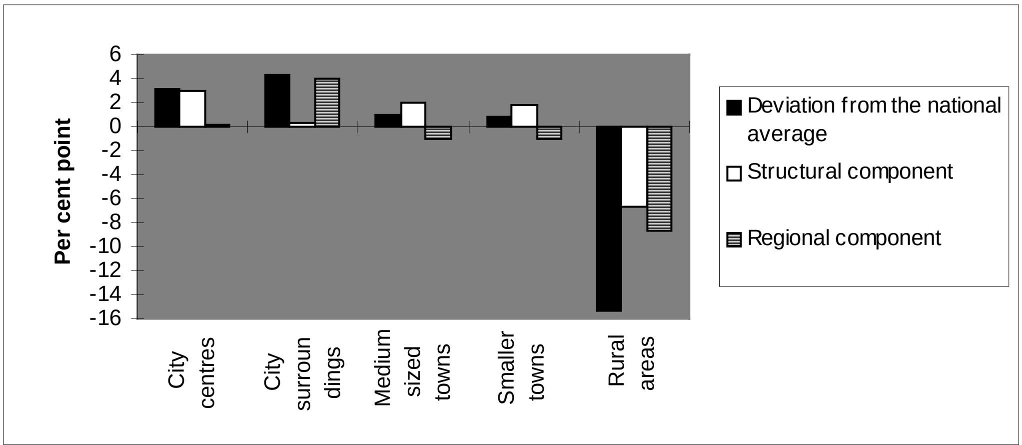
Small firms are generally less innovative than large firms, both in terms of share of firms with innovation costs and share of firms with new or significantly altered products. The size structure of firms in an area will thus affect the share of innovative firms, so that a relatively large share of big firms in an areas is likely to result in a relatively large share of innovative firms, and a large share of small firms is likely to result in a relatively small share of innovative firms.

Figure 4.6 shows that rural areas alone have a negative structural component, which is to say they have a dominance of small firms[19]. The rural areas also have a significant negative regional component, which means that there are overall fewer firms with innovation costs in the three size-categories in rural areas than in the

[19] We have used three firm size categories in order to calculate the structural component in Figure 4.6; 0-19 employees, 20-79 employees, and more than 80 employees. Nås et. al. (1994) have established that there is a leap in the share of innovative firms in Norway in the size-categories above and below 20 employees and above and below 80 employees. The share of firms with innovation costs in the three categories is 20, 42 and 74% respectively.

country as a whole. The city centres display a positive structural component but a regional component approaching zero. This confirms the impression given by Figure 4.4 that the six city centres do not have a particularly large share of innovative firms, but that they perform favourably due to a positive size and industrial structure. The city surroundings, on the other hand, display a significant positive regional component, the only area-type to do so.

Figure 4.6: Share of firms with innovation costs 1992. Shift-share analysis by firm size



4.4. Summary and interpretation

The analyses of geographical variation in innovative activity in Norwegian manufacturing industry in 1992 have displayed the following main patterns:

1. Most firms are non-innovative in the view of the indicators used. 60% of firms had no costs associated with innovation in 1992, and 77% of firms had no new products or products that were significantly altered during the three preceding years.
2. However, innovative firms (firms with costs associated with innovation, or new or significantly altered products) are found in all areas of the country.
3. The proportion of innovative firms is greatest in the most central areas, i.e., in the areas around the Oslo Fjord. However, high shares of innovative firms are also found in other large, medium and small towns. Thus the most central areas do not massively outperform other areas.
4. Shares of innovative firms in line with or above the national average rate are found in communes where manufacturing dominates business activity, or in communes where there is specialisation in one manufacturing sector. On the whole, innovative firms are spread evenly over large areas of the country.
5. The share of innovative manufacturing firms is lowest in the least central areas, and in those areas where the economy is dominated by primary industry. These areas face a double problem; a relatively high number of firms in what are nationally non-innovative sectors, and a relatively high number of small firms, but first and foremost these areas have low shares of innovative firms within the individual sectors and size-categories.

6. The opposite is often the case in central areas. These areas have both a favourable industrial and firm structure as well as a relatively high number of innovative firms within individual industrial sectors and firm size-categories. The six largest city communes, however, have share of innovative firms that is higher than the national average due only to a positive structural component; these areas have relatively high numbers of large firms and many firms in innovative manufacturing sectors. Thus these areas do not have particularly high numbers of innovative firms when we adjust for the areas' industrial and firm structure.

The conclusions drawn here showing a relatively wide spread of innovative activity does not fit the picture presented by the linear innovation model and the concomitant model for regional, hierarchical division of labour. In the linear model, R&D activity is seen as the basis for innovation. One would accordingly expect the most central, city areas to contain the highest shares of innovative firms, as it is here that we find the universities, many of the public R&D institutes as well as R&D departments in private companies.

The network-based innovation model provides a better basis for the interpretation of the empirical results presented in this chapter, as it places more emphasis on place-specific, regional factors in the innovation process. The conclusion that there is a wide spread of innovative activity also concurs with other data on regional manufacturing development. Significant *geographic deconcentration* of employment has taken place in Norwegian manufacturing during recent decades. The most central areas, in particular cities and medium-sized towns in Eastern Norway have experienced significant losses in manufacturing jobs. In the period 1970 to 1990, manufacturing in Eastern Norway lost over 70 000 man years (Isaksen and Spilling 1996). The more peripheral areas of the country experienced growth in manufacturing jobs during the 1980s, and had well below average rates of decline during the 1990s.

Loss of manufacturing jobs in city-areas has largely taken place in low-tech - and to a certain degree in medium-tech - manufacturing[20]. High-tech manufacturing expanded in city-areas during the first half of the 1980s, and almost two-thirds of the jobs in this sector were found in city-areas in 1990 (Isaksen and Spilling 1996). The high-tech manufacturing sector is negligible outside city-areas and medium-sized towns. The relatively positive development in employment in peripheral areas has therefore occurred in low and medium-tech manufacturing.

During the last two decades, then, low-tech and medium-tech manufacturing in non-central areas has developed more strongly than the equivalent type of manufacturing in city-areas. There may be many reasons for this development. In some respects, less central areas offer superior production conditions to city-areas. In less central areas, firms can make use of regional policy instrument, and also have access to a stable work force with generally lower wage levels than in city-areas. Yet it is also reasonable to assume that the relatively positive developments in manufacturing in these areas reflects that firms in less central areas are as innovative as city-area firms

[20] The division of manufacturing into low, medium and high-tech is based on a standard developed by the OECD. Cf. Isaksen and Spilling (1996).

in the same sector. In the long-run, most firms cannot compete solely on the basis of low wage costs, but must also develop new products and processes.

Some favourable developments in manufacturing in non-central areas may be determined by city-areas. That is to say, city firms may establish branch plants or take over firms in other areas, or make use of subcontractors outside the city-area. Jobs may thus originate in city-areas, and the innovation process may to a large degree take place in the city-areas.

Various data, however, suggest that job growth in non-central areas is often based locally. For example, almost 15% of jobs in secondary industries in 1990 were external controlled (Isaksen and Spilling 1996)[21]. External control means that firms are owned by companies in a different county than that where the firm is located[22]. In contrast, then, 85% of employment in secondary firms took place in locally-owned firms. In addition, much of the net growth in manufacturing during the 1980s took place in firms with fewer than 20 employees. This group accounted for approximately 40% of the job growth from expansions of existing firms during 1980-1990, but accounted for only 17% of employment in 1980. (Isaksen and Spilling 1996). In addition, significant growth is taking place in small and newly established manufacturing firms.

A significant share of the job growth in Norwegian manufacturing has occurred from small, often locally owned, firms in non-central areas. We are here talking about a gross growth, which is counterbalanced by a loss of jobs in other firms. Growth amongst this type of firm has continued for two decades, and must be founded on a certain level of innovative activity. This has been confirmed by this report, which shows significant geographical spread of innovative activity.

[21] Manufacturing accounts for approximately three-quarters of employment in secondary industry.

[22] It is not possible to carry out a comprehensive mapping of external control practices. 15% is a conservative estimate.

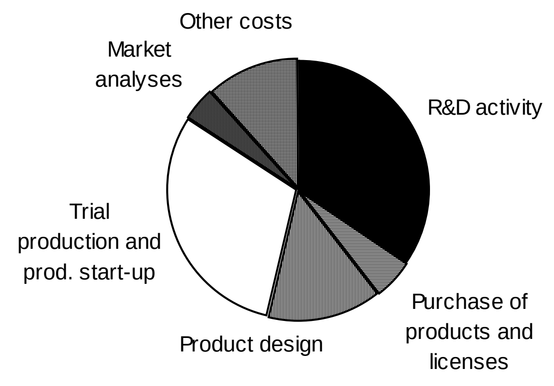
5. How does the innovation process take place in different areas?

Chapter 4 charted the extent of innovative activity in different areas of Norway. In this chapter we will examine more closely *how* innovation takes place in different areas, using two main groups of indicators from the national innovation survey. First, we present an overview of the different activities involved in the innovation process, before charting the sources of information for, and aims and obstacles to, innovative activity.

5.1 Types of innovation activity

In 1992, manufacturing firms spent approximately one-third of costs associated with innovation on research and development (Figure 5.1). The second largest cost component was associated with trial production and production start-up, which accounted for 30% of costs. Product design accounted for 14%, whilst relatively small amounts were associated with the purchase of products and licenses, and market analyses[23].

Figure 5.1: Distribution of innovation costs on different activities. 1992



The distribution of innovation costs between these different components varies significantly between different parts of the country (Table 5.1)[24]. In the capital

[23] These are un-weighted averages, i.e. not weighted according to the turnover or something else in the firms.

[24] Table 5.1 shows the three greatest costs-components associated with innovative activity. 350 firms in the innovation survey reported costs associated with innovation *and* split these costs between different types of activity. On the basis of such a small response group, it is impossible to draw conclusions on the basis of small variations between areas.

region, almost half of costs associated with innovation go on R&D; the highest share in the country. The share of costs associated with R&D is also greater than the national average in south and south-west. In less central parts of the country, such as the north-east and north-west, R&D costs make up only 20% of total innovation costs.

The relatively high share of R&D in the capital region means that firms in these areas generally have lower shares associated with other cost-components. In less central parts the situation is the opposite, with firms innovating mainly on the basis of other activities than R&D. In the north-west we find relatively high shares of costs associated with product design and also with trial production and production start-up. In Northern Norway firms have relatively high levels of costs associated with trial production and the purchase of products and licenses.

Table 5.1: Distribution of innovation costs on different activities*. Parts of the country. 1992

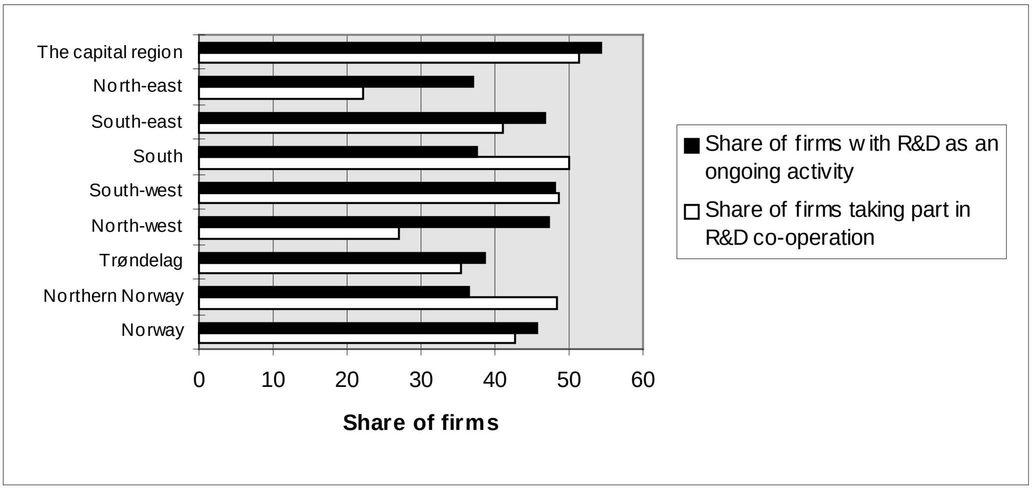
		Per cent distribution of cost on particular activities:		
Parts of the country	Number of firms**	R&D activity	Product design	Trial prod. and prod. start-up
The capital region	70	48,0	11,2	21,3
North-east	23	20,7	14,8	32,0
South-east	81	32,0	11,9	35,5
South	28	37,2	13,4	29,3
South-west	65	37,8	15,7	26,7
North-west	30	19,6	27,0	40,0
Trøndelag	25	32,8	14,6	33,6
Northern Norway	28	24,8	9,2	36,4
Norway	350	34,4	14,0	30,6

* The three activities where firms spent most costs when innovating.
** Refers to the number of firms that answered the question regarding distribution of innovation costs on different activities.

That firms are altogether most R&D intensive in the capital region is confirmed by the two indicators presented in Figure 5.2. The capital region has the highest share of firms with R&D as an ongoing activity as well as the highest share of firms taking part in R&D co-operation with other firms or institutions in 1992[25]. Relatively central parts of the country as the south-west and south-east also display high values for both indicators. The north-east and Trøndelag display low values.

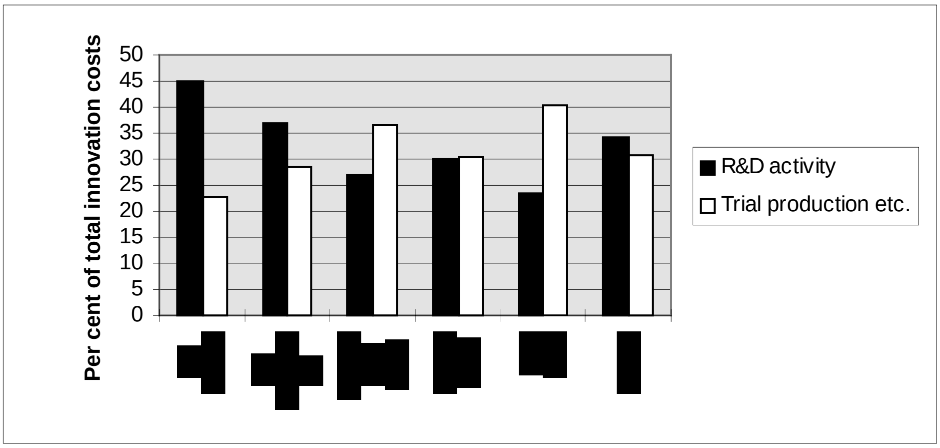
[25] These calculations include those firms that answered yes or no to the relevant questions in the innovation survey, 426 and 423 firms respectively.

Figure 5.2: Share of firms with R&D activity and taking part in R&D co-operation. 1992



The same centre-periphery pattern emerges when we examine the five area-types. In city centres R&D is far more important than in the country as a whole (Figure 5.3), or at least, firms in city centres have a far greater share of their innovation costs associated with R&D than firms in other area-types. In contrast, trial production and production start-up are far more important to the innovation process outside city centres[26]. City surroundings are in an intermediate position, with second highest levels of R&D costs and second lowest shares of costs associated with trial production and production start-up.

Figure 5.3: Two kinds of innovation costs. 1992

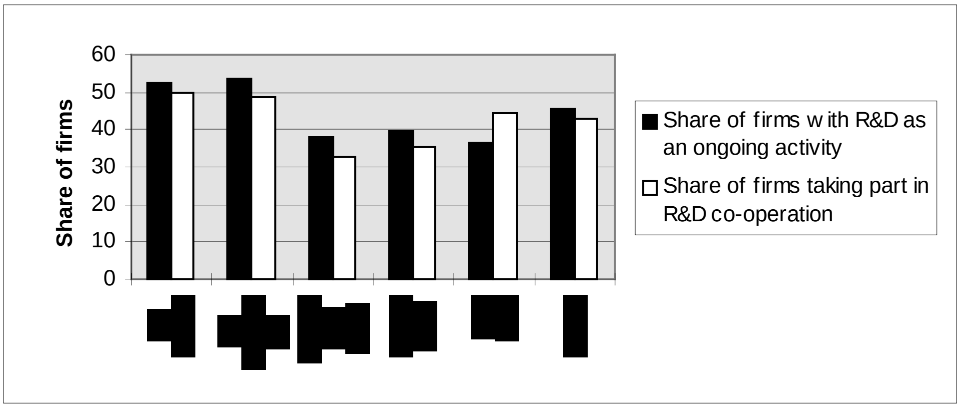


A clear distinction emerges between city-areas and the rest of the country when we examine the share of firms with R&D activity and those taking part in R&D co-

[26] Figure 5.3 only shows the share of costs associated with R&D activities and with trial production and production start-up. These are the two largest cost-components for all area-types, and are also the cost-components that vary significantly between area-types.

operation (Figure 5.4). City centres and city surroundings have a higher share of firms with R&D activity on an ongoing basis (as opposed to more sporadic R&D) than the three other area-types. The same distinction between area-types appears when we examine the share of firms taking part in R&D co-operation, which is again highest in city centres and city surroundings. However, rural areas also have a remarkably large share of firms taking part in R&D co-operation.

Figure 5.4: Share of firms with R&D activity and taking part in R&D co-operation. 1992

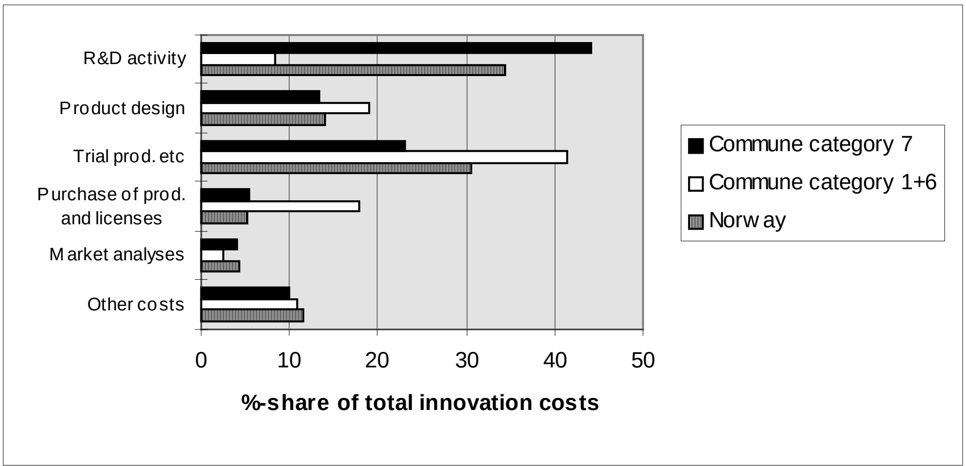


Finally, if we examine the commune categories, we find that three types of communes have a distribution of innovative activity that distinguish them from the national average. These commune categories are 7 (central service-industry communes) on the one hand and 1 (primary industry communes) and 6 (less central service-industry communes) on the other. The remaining commune categories have distributions of innovation costs close to the national average[27].

Central service-industry communes have high costs associated with R&D, whilst firms in the primary industry communes and in less-central service-industry communes hardly register any R&D costs at all (Figure 5.5). The shares of innovation costs associated with product design and with trial production and production start-up, on the other hand, are relatively high in the two less central commune categories and below average in the central service-industry commune category. Further, the share of innovation costs associated with the purchase of products and licenses is relatively high for commune categories 1 and 6, whilst the remainder of the country has very low shares associated with these costs.

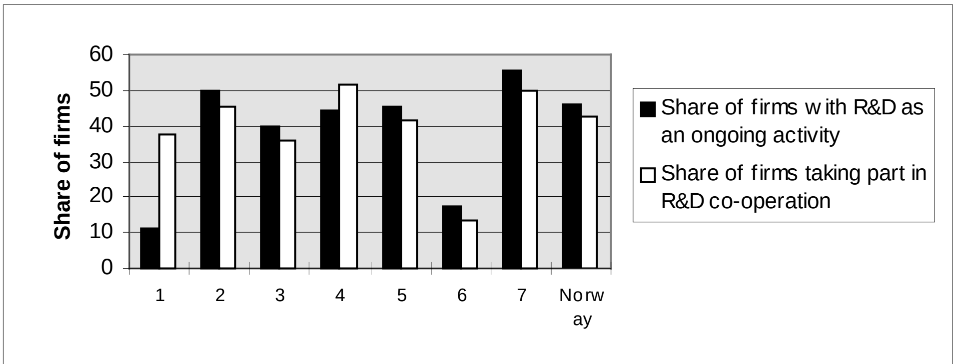
[27] Figure 5.5 therefore, only shows the shares of different innovation costs in commune categories 1 and 6 together, and commune category 7. Commune categories 1 and 6 are presented as a whole as very few firms from these areas (5 and 14 respectively) responded to the relevant questions in the innovation survey. Commune category 7 includes 169 firms.

Figure 5.5: Distribution of innovation costs on different activities. 1992



Further, when looking at commune categories, the two indicators of R&D activity and R&D co-operation reveal a by now familiar pattern (Figure 5.6). Commune category 7, which includes many of the most centrally located communes, has a high share of firms with R&D activity and in R&D co-operation. Commune categories 1 and 6 (primary industry communes and less central service-industry communes) have very low values here, although the primary industry commune category does have a relatively large share of firms in R&D co-operation[28]. Category 3 (manufacturing communes) also displays lower shares than the national average, whilst less central commune categories such as agriculture and manufacturing combined (category 2) and less central service and manufacturing communes combined (category 4) have shares that are level with or above the national average.

Figure 5.6: Share of firms with R&D activity and taking part in R&D co-operation. 1992



Brief Summary

All three of the regional classifications reveal a clear centre-periphery pattern for how the innovation process takes place. Firms in central areas of the country make most use of R&D in the innovation process, a fact which may suggest that innovation

[28] It must be noted that commune category 1 in particular has a low response rate to the relevant questions, so that it is difficult to draw any firm conclusions for this category.

processes in these areas are to a greater degree oriented towards *radical innovations* (new products and processes). Systematic research and development, and R&D competence are namely essential to this type of innovation (Freeman 1995). The share of innovation costs associated with R&D activity is also approximately equal to the national average in less central areas where manufacturing plays an important part in the local economy. In less central areas with little manufacturing, however, innovation largely takes place in other ways. Firms in these areas spend a fair amount on the purchase of products and licenses, as well as on trial production, production start-up and product design. This suggests that *incremental innovations* (changes to already existing products and processes) are important to the innovation process in these areas, but also that firms "import" and alter innovations from outside.

5.2 Aims, sources of information, and obstacles

Finally, to expand on the differences in the innovation process in different areas, we will here analyse geographical variations in aims, sources of information and obstacles to the innovation process.

Aims

The national innovation survey delineated 17 different sub-aims of firms' innovation. Figure 5.7 splits these aims into two main groups; aims associated with incremental innovation and aims associated with radical innovation[29]. The aims most often interpreted as of great or decisive importance for the firms are those associated with incremental innovation. The three most important aims are to improve product quality, to increase or maintain market shares, and to reduce production costs by reducing production time. Aims connected to radical innovation are almost without exception seen as least important by firms.

Figure 5.8 charts the importance of aims associated with radical innovations according to the five area-types[30]. Replacing discontinued products emerges as an aim that is more important in rural areas than in the remainder of the country. This is confirmed if we examine the distribution according to commune categories. Replacing discontinued products is most important to the less central communes. In contrast, fewest firms consider this aim to be important or decisive in commune categories 5 and 7, that is in central, combined service-industry and manufacturing communes and central service-industry communes.

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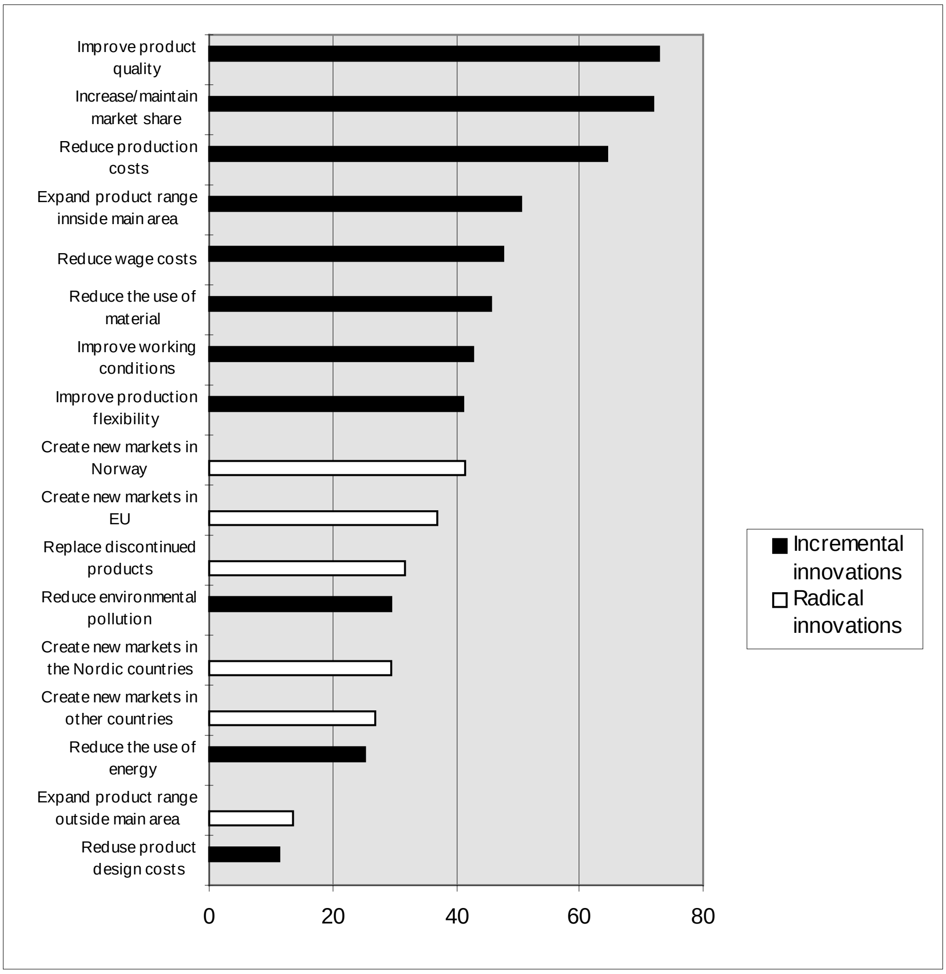
[29] This kind of split between radical and incremental innovation was not included in the innovation survey, and it is difficult to classify the aims thus after the event. Nevertheless, we have placed aims to "replace discontinued products", "expand product range outside main area of activity" and "create new markets" in the category of radical innovation aims. The remaining aims are seen in connection with incremental innovation aims.

[30] When responses are distributed according to parts of the country we find an intricate pattern that is hard to interpret. Subsequently this situation is not presented here.

Figure 5.7: Share of firms which state that different aims have great or decisive importance for firm's innovation activity



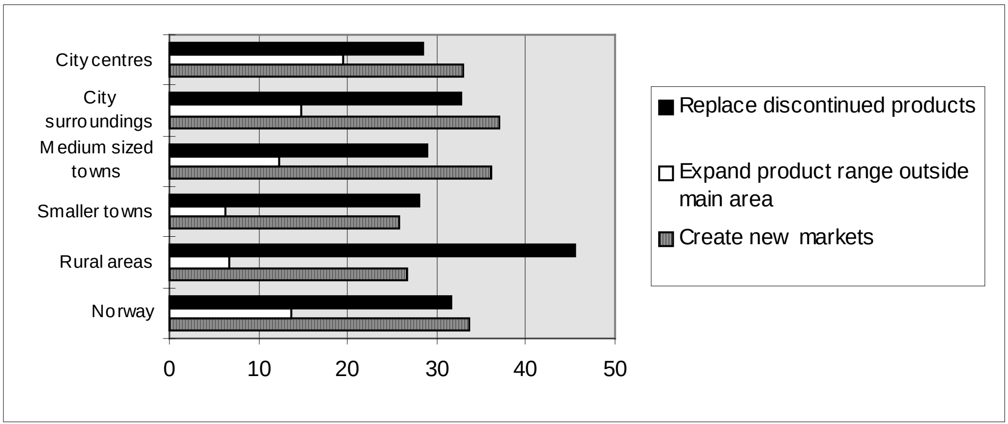
The two other aims included in Figure 5.8 - increasing product range outside of main areas of activity and the creation of new markets[31] - are considered important by the greatest number of firms in cities and medium-sized towns. Looking again at the commune categories, we find that expansion of product range is relatively speaking most important in central service-industry communes and in manufacturing communes. These two commune categories, along with less central combined service-industry and manufacturing communes, also contain the relatively largest number of firms which consider the creation of new markets to be an important aim. Primary industry communes and less central service-industry communes have the lowest values for both these aims.

Thus a geographical pattern emerges when we examine firms' aims. Two of the aims considered in connection with radical innovations are most important to firms in the most central areas, and in areas where manufacturing is relatively important. This

[31] The indicator "to create new markets" is split into four sub-aims in the innovation survey, namely to create new markets in Norway, Norden, EU excluding Denmark and Other countries respectively.

confirms the view given in Chapter 5.1 that the innovation process in central areas, more than in the rest of the country, is aimed more at radical innovations. However, replacing discontinued products is most important in rural areas.

Figure 5.8: Share of firms which state that different aims have great or decisive importance for firm's innovation activity



Sources of information

Firms employ a variety of external sources of information in the innovation process, in addition to the development of knowledge internally within the firm and company. Clients, together with suppliers of equipment and materials, are considered to be the most important sources of information by firms in the national innovation survey (Nås et.al 1994). This reflects the fact that firms often innovate in co-operation with clients and suppliers. Another very important source of information is the firm itself, reflecting the fact that firms try to build up competence in key technological areas over time. Last on the list of sources of information considered most important by firms in the national innovation survey we find "what we may call the knowledge infrastructure, namely patent documents, consultants, universities and colleges, public research institutes and sectoral research institutes" (Nås et. al. 1994: 50).

Figure 5.9 shows sources of information grouped into four main categories. The figure displays the same pattern for all area-types[32]. Most firms consider various internal sources and external market-sources to be of decisive or great importance to the innovation process. Clients and suppliers are thus extremely important external sources of information to firms in all area-types.

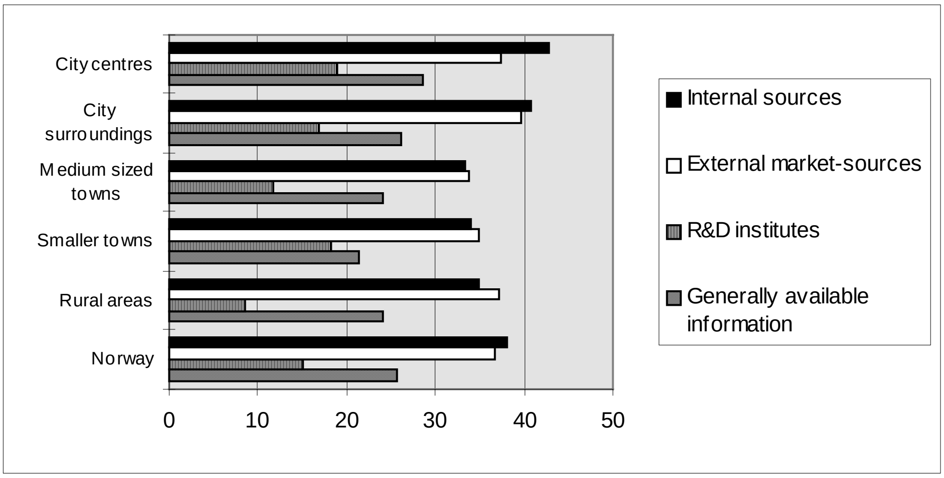
R&D institutes are considered to be the least important source of information for innovative activity by firms in all area-types[33]. Regional innovation policy often tries to link firms to different types of R&D institutions (Isaksen 1995). Such an approach

[32] We present these results only according to area-types and not other types of area-classification. Examining the patterns according to parts of the country and commune-categories does not provide any additional information other than that mentioned in the text.

[33] The same is true when we examine sources of information according to different parts of the country.

may at first glance seem odd, considering that firms themselves see R&D institutions as least important as a source of information. Figure 5.9 further suggests that the network-based innovation model (Chapter 2.2) is most in touch with how innovative activity actually takes place in Norwegian manufacturing. The linear innovation model, where R&D forms the basis for innovation, would seem to be ill suited to the results in Figure 5.9.

Figure 5.9: Share of firms answering that different main sources of information have great or decisive importance for firm's innovation activity



A higher share of firms in city areas, and in small towns, consider R&D institutions to be important sources of information. City firms put greater emphasis on universities and colleges and public research institutes as information sources than other firms in Norway. This is particularly true for firms in the capital region. Firms in smaller towns make much greater use of sectoral research institutes than other firms, at least, a far greater proportion of these firms consider sectoral research institutes to be of great or decisive importance as a source of information than firms in other areas. Considering different parts of the country, we find that firms in Northern Norway and Trøndelag make most use of sectoral research institutes. In rural areas consultancy firms are considered more important than elsewhere in the country. Thus firms in different area types emphasise different parts of the R&D sector. Somewhat simply, we might say that city firms make most use of basic research institutes, whilst firms in the least central areas make more use of the applied R&D sector.

The indicator "generally available information" in Figure 5.9 shows the degree to which firms consider trade conferences, meetings, trade periodicals and journals to be important sources of information. This indicator in particular varies between area types. Trade conferences etc. are used most by firms in city areas, and looking at parts of the country by firms in the capital region and Trøndelag, , where the country's technical university is situated in Trondheim.

Obstacles

Knowledge about the obstacles to innovation may have a central role to play in the development of regional innovation policy, as one of the main aims of such policy is to help solve problems associated with sub-optimal innovation activity (cf. Nås et. al. 1994). The three greatest obstacles cited in the innovation survey are that innovation costs are too great, that the innovative capacity of the firm is too small, and that calculated risk is too great.

Figure 5.10 shows three main categories of obstacles. The main pattern is similar for all area types, although there is a minor tendency for firms in rural areas to perceive greater obstacles than firms in other areas.

The main category “economic obstacles” is seen as most important in all area types, which suggests that there is a role for traditional firm-based support in innovation policy. All four aspects included in this category are considered to be important obstacles by relatively greater numbers of firms in rural areas than otherwise in the country[34]. Other regional categorisations also show that peripheral areas have greatest difficulty with economic obstacles. Trøndelag, Northern Norway and the less central commune categories have relatively highest numbers of firms which consider economic obstacles to be important.

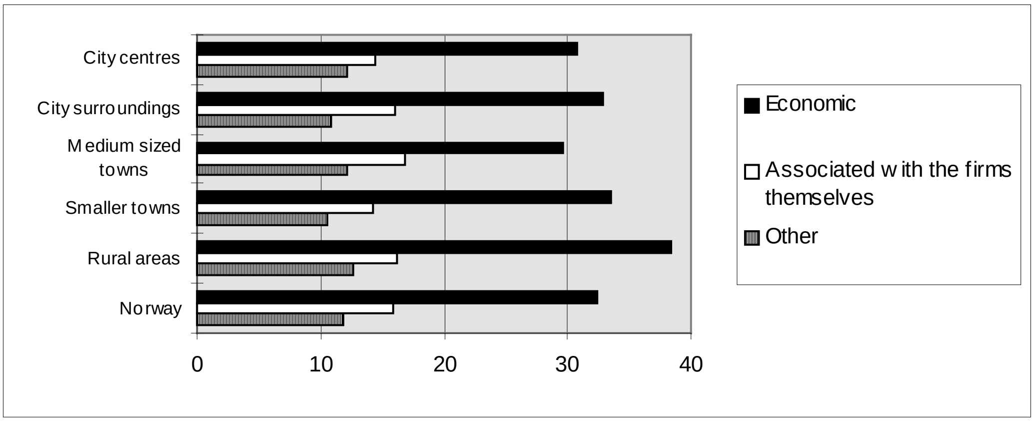
The two most important obstacles associated with the firms themselves are that the firm’s innovative capacity is too small and that there is a lack of qualified personnel. There is no clear regional pattern for these two factors. Rural areas have relatively highest numbers of firms which consider a lack of qualified personnel to be an important obstacle. On the other hand, rural areas have relatively fewest firms which consider the innovative capacity of the firm to be too small.

A centre-periphery pattern emerges for the other factors associated with firms themselves. Relatively greater numbers of firms in Northern Norway consider a lack of technological and market information as an important or decisive obstacle to innovation. Further, primary industry communes and less-central service-industry communes have relatively higher numbers of firms that consider lack of opportunity to co-operate with other firms and institutions to be an important obstacle.

The remaining category “other factors” generally has the same response rate from all area types, giving no particular geographical pattern here either.

[34] The aspects included in the category “economic obstacles” are that innovation costs are too great, calculated risks are too great, there is a lack of finance, and innovation repayment time-span is too long.

Figure 5.10: Share of firms answering that different main factors have great or decisive importance as obstacles for firm's innovation activity



5.3 Summary and interpretation

There are many similarities between the innovation processes in different parts of Norway. For example, clients and suppliers are important sources of information for firms in all areas. Nevertheless there are important differences:

1. Firms in central areas make most use of research and development in the innovation process. In these areas, costs associated with R&D activity account for a greater share of total innovation costs than in the rest of the country. In less central areas where manufacturing is important, the share of innovation costs associated with R&D is approximately equal to the national average.
2. In less-central areas where there is little manufacturing, innovation mainly takes place by means other than R&D. Firms in these areas spend significant resources on the purchase of products and licenses, as well as trial production, production start-up and product design. Otherwise, firms in different areas emphasise different aspects of the R&D sector. Firms in the most peripheral areas make most use of the applied R&D sector (sectoral research institutes and consultancy firms), whilst city firms make most use of basic-research institutions (universities and public research institutes).
3. In central areas, and partly in other areas where manufacturing is important, the innovation process is oriented toward radical innovations to a greater degree than elsewhere in the country. As mentioned, in these areas R&D makes up a significant share of total innovation costs, and two of the aims associated with radical innovations are more significant for firms in these areas than elsewhere in the country.
4. In less central areas where manufacturing does not dominate, incremental innovation appears to be relatively more important. This applies to changes to existing products and processes, as well as firms "importing" and adjusting innovations from outside. However, the replacement of discontinued products is a more important aim in these areas than elsewhere. Creating new products outside of current fields of activity, on the other hand, is most important in central areas.

5. We find that a centre-periphery pattern emerges when we consider obstacles to the innovation process, too. Peripheral firms consider economic factors to be more important obstacles than firms elsewhere. Economic obstacles basically concern the financing of innovation activities. Secondly, firms in peripheral areas consider lack of qualified personnel to be a greater obstacle than firms elsewhere. Further, relatively more firms in Northern Norway consider lack of technological and market information to be an important or decisive obstacle to the innovation process.

That city-firms make most use of R&D in the innovation process, and that they are more oriented towards radical innovation, is not surprising considering the fact that cities are often thought of as innovation centres. New products, production processes and marketing ideas often originate in cities. “A highly qualified work force and proximity to specialised suppliers is of great importance to the innovation phase. Such conditions are found first and foremost in the most central regions, i.e., cities, and these areas consequently have the best conditions to initiate new product cycles” (Meissner and Stokka 1991:84).

That Norwegian cities can function as innovation centres can be seen by examining different kinds of empirical material. Firstly, the most significant growth in new and technologically advanced industries during the 1980s took place in city areas, and in particular in the Oslo area (Isaksen 1990a). City areas also have a large share of jobs in advanced producer services. Secondly, the work force is overall more highly educated in city areas than in the rest of the country (Meissner and Stokka 1991). Education levels are highest in the Oslo area. City areas have high education levels even when we adjust for the industrial structure, namely that city areas have relatively many employees in industries with high levels of education. Thus, cities also have many highly educated employees within individual sectors. Thirdly, the R&D sector is to a large degree concentrated around Norway’s university towns. At the end of the 1980s, almost half of all R&D took place in the capital region (the county of Oslo and Akershus). If we include three other counties which all have one of the four largest cities in Norway (the county of Rogaland, Hordaland and Sør-Trøndelag) we account for approximately 80% of R&D (Meissner and Stokka 1991).

The three points listed above are interlinked. Many new and advanced firms originated in city R&D milieus. The presence of large numbers of technologically advanced firms, as well as the research departments of large companies, gives rise to relatively high levels of R&D in city business activity. R&D milieus and technologically advanced firms contribute to high level of education amongst the work force. High standards of education and geographic proximity to R&D institutions encourages co-operation and the use of R&D by city firms.

Thus there are many factors contributing to a greater use of R&D in cities compared to the rest of the country, which suggests that the chapter presents an accurate picture of the main features in innovation activity in different areas of Norway. The extent of innovative activity, measured by share of firms with innovation costs and share of firms with new or significantly altered products, is not particularly great in city areas (Chapter 4). However, innovation takes place by different methods in city-areas compared to the rest of the country, in that R&D activity and co-operation with basic-research institutes have a greater role on innovative activity.

6. Summary and discussion

In this chapter we return to the four questions that arose in Chapter 3. The two first questions, concerning geographic variation in the extent of innovative activity and the manner in which innovation takes place, are thoroughly analysed in Chapters 4 and 5. The main pattern which emerges is one of an even spread of innovative activity across the country, with the exception of peripheral areas with little manufacturing. Secondly, most R&D activity takes place in firms in central areas, and these areas are also more oriented towards radical innovation. This is also true to some extent of less-central areas where manufacturing is important to the local economy. Innovation takes place by means other than R&D in peripheral areas where manufacturing is unimportant. Further, in these areas innovative activity is directed more towards incremental innovation, in addition to the import of innovations from outside.

The two final questions thus remain to be answered. These questions concern firstly, which of the two innovation models presented in Chapter 2 can best aid our understanding of the empirical results of the report, and secondly, the matter of how regional innovation policy should be formed to suit different area types. These two questions are interlinked. The “best” innovation model must be identified, and then used as a basis for the discussion of regional innovation policy-making.

6.1 Which model is most fruitful?

This report clearly shows that the network-based innovation model is most accurate in describing the innovation process in Norwegian manufacturing. In the first instance, this can be justified by three general observations which have to some extent been charted earlier (Nås et.al 1994).

1. The innovation process is made up of many activities in addition to “pure” R&D. As an unweighted average, approximately one-third of the innovation costs of manufacturing firms was in 1992 spent on R&D. The proportion of costs associated with R&D varies between different areas. In city areas such costs account for almost half of innovation costs, compared to one-quarter in rural areas.
2. Firms innovate in co-operation with many other firms and institutions, in addition to knowledge-development internal to the firms and companies. Clients, along with suppliers of equipment and materials, are important sources of information in connection with innovation for firms in all areas. Lowest on the list of important sources of information we find the knowledge infrastructure, which includes R&D institutions. This is true for all area types, even though R&D institutions are made most use of by firms in city areas.
3. Firms put most emphasis on the importance of incremental innovations, or rather, firms in all areas consider the aims associated with incremental innovations to be the most important aims of the innovation process. However, we find a centre-periphery pattern here also, with radical innovations valued more highly in city-areas than in peripheral areas.

The linear innovation model, which takes R&D as the basis for innovation and puts most emphasis on radical innovations developed in the research departments of large companies, does not agree with the results outlined in the three points above. The network-based innovation model, which emphasises incremental innovations based on “learning by doing” and “learning by interacting”, presents a more accurate picture of how innovative activity took place in Norwegian manufacturing during the early 1990s.

Geographical variation in the extent of innovative activity is also best explained by using the network-based model. This model anticipates a reasonably even spread of innovative activity, with higher rates of activity taking place in traditional manufacturing milieus, due to the important role played by uncodified and tacit knowledge about a production process amongst the work force. The linear innovation model would appear to anticipate a far greater geographic concentration of innovative activity than that found in Chapter 4.

We can thus conclude that the network-based innovation model can most accurately explain innovative activity in Norwegian manufacturing in the early 1990s. This does not mean, however, that the linear innovation model should be ignored . It does seem that the linear model is valid for central areas in particular, where firms co-operate with R&D institutions and are more heavily oriented towards radical innovations. This way of innovating in central areas reflects to a certain degree that these areas are dominated by large firms and firms in R&D intensive sectors such as pharmaceuticals and electronics.

6.2 Discussion of regional innovation policy

How then should a regional innovation policy be shaped if we take the network-based innovation model as our starting point?

The regional innovation policy pursued in Norway until now has been based on the linear innovation model rather than the network-based model. Policy has largely been to communicate research and development competence to, in particular, small and medium-sized firms (SMFs) in non-central areas. Different methods have been applied. In the 1980s policy was to build up regional research institutes and competence-centres to create contact and support between SMFs and national R&D institutions, in addition to providing various common services to regional firms (Isaksen 1995). Another policy tool has been the placement of district technology attachés in order to identify firms’ problems and support needs, and to link firms with relevant national R&D milieus. The focus on spreading competence from national R&D milieus can also be seen in the emphasis placed on the role of towns and cities in the spread of knowledge to peripheral areas in a recent Parliamentary report on regional policy (St.meld. nr. 33 (1992-93)). Here, it is underlined that national specialist knowledge must also be used outside of central areas, and that there is a need to establish local intermediary bodies between national R&D institutions and small and medium-sized peripheral firms.

The spread of R&D from national milieus to peripheral firms is without doubt an important aspect of any regional innovation policy. Nevertheless, this policy must be supplemented by other tools once we make the network-based innovation model the basis for policy-making. In this model innovation is understood as a process of interaction between firms and their environment, and thus the concept of *innovation system* becomes important (cf. Chapter 2.3). Regional innovation policy until now has especially aimed at improving those parts of the innovation system made up of national and local R&D institutions and firms. Clients and suppliers, however, are far more important as sources of information in the innovation process than R&D institutions. Thus policy must include all participants in the innovation system, as “networks of relationships... are necessary for firms to innovate” (Freeman 1995: 5).

Innovation systems can be international, national or regional/local. An important - perhaps the *most* important - target group for regional innovation policy is traditional small and medium-sized enterprises, and *regional innovation* systems are particularly important to these firms. Chabbal (1995: 109) thus argues that “innovation policy is aimed primarily at SMEs[35].(...) An innovation policy for SMEs is above all a local policy: it is, therefore, essentially the domain of regional policies”. Similarly, Cooke (1995: 19) argues that the “the region (is) the optimal level of industrial, governmental, and technological support, especially for small and medium-sized enterprises (SMEs)”. Traditional small and medium-sized enterprises often lack the competence and resources needed to carry out their own research and development, they may also have problems in recognising their own needs in the innovation process, and further, they lack opportunities to partake in wide-reaching networks (Tödtling 1994). Large firms, and also resourceful small firms, are more able to connect with national and international networks, e.g., by co-operating with national research institutions. These latter firms often depend more on national technology policy than on regional innovation policy.

This report was based on the need to establish greater knowledge about geographical variations in innovative activity, in order to facilitate the formulation of regional innovation policy suited to varying local conditions. There is no one regional innovation policy that can be applied to all areas. In the following, we have split the country into three main area-types which describe important regional differences in innovative activity. Subsequently, we discuss the formulation of regional innovation policy for each of the three area-types. However, significant variation will still be found within each area-type. Concrete guidelines for regional innovation policy in a particular area require detailed information about local industry and innovative activity of the type established by the STEP-Group’s innovation survey in the counties of Finnmark and Møre og Romsdal. In the following discussion the results of these surveys are used, as these counties exemplify two of the area types to be discussed.

1) Peripheral areas with little manufacturing (the case of Finnmark)

The first area-type covers peripheral areas with small manufacturing milieus, and where primary industries are often relatively important. These areas have low levels of innovative activity in manufacturing compared with the rest of the country, and they have relatively large numbers of firms in non-innovative industries. The innovative activity is directed towards incremental innovation. Firms make little use of R&D in the innovation process, and R&D competence is largely supplied by

[35] Small and medium-sized enterprises

consultants. In general, firms perceive a greater number of obstacle to innovation than firms elsewhere. Firms in these areas put more emphasis on economic factors, lack of qualified personnel and lack of technological and market information as obstacles to innovation.

The creation of regional innovation systems (centred around innovative manufacturing firms) will often be ill-suited to areas such as these, on the grounds of a weak manufacturing base. There are often few local firms with which to co-operate, and there are often few service firms and R&D institutions in the area. In such areas the innovation process must to a greater degree be stimulated by connecting firms with innovation systems elsewhere, and through direct support and advice to individual firms.

The innovation survey in Finnmark (Wiig 1995) did indeed show that for manufacturing firms, the "home-county" is an important "economic base"[36]. 80% of firms have a significant proportion of sales in Finnmark, and this is particularly the case for small firms and non-innovative firms. One third of firms also have their most important supplier in the county.

Manufacturing firms in Finnmark, however, make little use of regional factors in their innovative activity. There is little horizontal co-operation between competing manufacturing firms in the county, and little contact between firms and regional colleges and research institutions. The regional innovation system is weak, and innovative firms are dependent on national and international innovation systems. Two of the six concrete proposals put forward to increase innovation amongst manufacturing firms in Finnmark as a result of the innovation survey, thus concern the use of regional institutions as intermediary bodies. Research institutions, but also regional authorities, should help firms to make contact with relevant national or international research milieus, as well as with firms in other areas. Firms lack information about which milieus to contact in order to gain information or R&D services. Traditional tools of regional innovation policy thus continue to be relevant for firms in Finnmark.

Two of the remaining proposals to increase innovation capacity in Finnmark concern strengthening of the regional college and research system[37]. There is no technical education at college level available in the county. Nor are there any R&D institutions that are relevant to the fishing industry, which is the dominant sector in the county. However, there is an important R&D-institute (The Norwegian Institute of Fisheries and Aquaculture Ltd.), as well as an University situated in Tromsø, in the nearby county to Finnmark. Thus, it may be as relevant to strengthen the contact between these R&D institutions and local firms than strengthen the R&D system within Finnmark. The county-border is not relevant in this context as firms have access to important R&D competence in Northern Norway, and most likely can take part in a regional innovation system covering particularly the fishing industry in the northern part of Norway.

[36] Finnmark is only weakly industrialised (Wiig 1995), and most of the area belongs in area-type category 1. About three-quarters of manufacturing employment in the county is in fish-processing.

[37] One alternative is also to strengthen links between the college in Alta in Finnmark and the Engineering College in Narvik in the county of Nordland.

Both the proposals to strengthen the education and research system in Finnmark, to strengthen the contact to nearby research institutions and to increase the role of regional institutions as intermediary bodies, is in line with traditional innovation policy. Bessant and Rush (1995) thus emphasis *bridging institutions* as important tools of regional innovation policy. The functions of these institutions are to a) assist firms in analysing their situation, i.e., to articulate and define their particular needs in relation to the innovation process, b) link firms with external consultants and other institutions that offer the competences needed by the firm, and c) advise firms (SMFs in particular) in order to compensate for a lack of knowledge within the firms.

Such *bridging institutions* are similar to the different types of technology and transfer centres in Germany and France (Isaksen 1995). These centres provide technological services to small and medium-sized firms. These are services which are not necessarily based on the latest research findings, but on information that is new and relevant to the firms. The centres are run by applied R&D institutes, university technical institutes and in particular by technical colleges. Management of the centres takes place in co-operation with regional authorities and companies. Finnmark appears to lack the kind of institution that could run this kind of technology centre. However, the Innovation and New Technology Programme for Northern Norway (the NT Programme) act as a bridging institution to some extent. This programme gives financial support to product and process development as well as market development in Finnmark and the two other counties in Northern Norway (Isaksen et. al. 1996). The programme helps to strengthen co-operation between firms and R&D institutions, both in Northern Norway and outside this part of the country, as well as with other competence centres through a system of “technological advisory contracts”. Moreover, the programme act as a proactive mentor in firms innovation process, providing all-round support (such as assistance with project organisation, strategy development and market research), and having long-term relations with their target group of the most innovative firms in Northern Norway.

In addition to lack of technological and market information, manufacturing firms in Finnmark consider lack of capital, and difficulties in attracting qualified personnel, to be important obstacles to the innovation process. Wiig’s (1995) final two proposals aim at addressing these problems, again using traditional regional policy tools such as support through the Norwegian Industrial and Regional Development Fund (SND), the NT Programme, and placement arrangements for engineers and economists (Arbo 1993).

2) Peripheral areas with manufacturing (Møre og Romsdal)

In the second area-type we find relatively high levels of manufacturing, in general linked to one or a small number of sectors. These areas may be dominated by a small number of large firms, or many small firms. Taken as a whole these areas display innovation rates that are at least equal to the national average. Apart from this, these areas are in many ways in an intermediate position between areas 1 (peripheral areas with little manufacturing) and 3 (central areas) when we consider innovation activity. In area 2, on the whole, firms have a greater share of innovation costs associated with R&D than in area 1. The innovation process is directed more towards radical innovation and firms perceive fewer obstacles to the innovation process. However, compared to area type 3, we find a lower share of R&D and less radical innovation.

In this area type, conditions are more conducive to the creation of regional innovation systems, particularly in those areas where we find many firms in the same production system. This makes co-operation possible for example between firms that produce final products and local subcontractors on product development and between firms in the same production stage on improving processes. Further, there may be scope for both private and public service firms to establish a technological infrastructure, and there may be grounds to set up vocational education directed towards dominant local industries.

However, the innovation survey in the county of Møre og Romsdal (Wiig and Wood 1995), a county with areas with significant manufacturing milieus, found a lack of regional innovation systems[38]. The regional innovation system can undoubtedly be better developed in other manufacturing milieus, as the example of the mechanical engineering industry in Jæren in the south-west of the country shows (Asheim 1993).

Møre og Romsdal has a variety of innovative manufacturing firms, but firms innovate mainly on their own, using already existing internal competence and capital. Incremental innovation through "learning by doing" and "learning by using" seem to dominate. Expenditure on R&D thus made up only 12% of total innovation costs. The emphasis on incremental innovation reflects the fact that manufacturing in Møre og Romsdal is dominated by firms in traditional industries such as furniture, shipbuilding, clothing and fish-processing. Further, some areas of the county have traditions of entrepreneurship, and there has undoubtedly been an accumulation of uncodified knowledge amongst the work force, which is important when carrying out smaller, incremental innovations.

What stops us from characterising the manufacturing milieu in Møre og Romsdal as a regional innovation system is the lack of co-operation between firms and R&D and educational establishments in the county. Firms often have a variety of local subcontractors, but there is little co-operation on innovation. Firms consider the biggest obstacle to innovation to be the risk of rapid imitation by other firms, a perception which limits co-operation between firms in the same sector. Small firms in particular fear imitation (Wiig and Wood 1995). Firms in Møre og Romsdal also have low levels of co-operation with other regional institutions. Proximity to regional educational and research institutions was considered to be of little importance by most firms, and again particularly by small firms.

A regional innovation policy for Møre og Romsdal could incorporate several of the proposals from the Finnmark example. In the first place, we find a need for technology centres here too. Møre og Romsdal is an area with many small firms in traditional industries. These are firms that have little opportunity to carry out R&D, and have problems in obtaining necessary information about technological

[38] Møre og Romsdal has a variety of so-called specialised industrial agglomerations, that is to say, labour market areas (travel to work areas) with above average levels of employment in certain industrial sectors (Isaksen and Spilling 1996). The county has three such industrial agglomerations with more than ten firms in the furniture industry (Volda/Ørsta, Stranda and Ålesund), three areas in textile and clothing (Ålesund, Stranda and Åndalsnes), three with shipbuilding (Molde, Kristiansund and Ullsteinvik) and three with fish-processing (Ålesund, Kristiansund and Ullsteinvik). Finnmark only has three such industrial agglomerations, all in fish-processing (Hammerfest, Honningsvåg and East-Finnmark).

development from institutions in the county. It appears that new institutions, or the restructuring of already existing institutions, is necessary, in that these are considered unimportant to innovation by most firms.

Any technology centres established in Møre og Romsdal, would face the important task of improving levels of innovation co-operation between firms. This type of co-operation is poorly developed, although “user-producer” co-operation in particular is considered to be important to innovation activity (Lundvall 1988). It is difficult to bring about co-operation between competitive firms, but the example of Jæren from TESA (Technical Cooperation) shows that this type of co-operation can be successful where it concerns improvement of production processes, which can benefit all firms (Asheim 1993). It would appear difficult to bring about co-operation on product development in Møre og Romsdal, due to the fact that firms - as mentioned above - consider the risk of imitation to be the greatest obstacle to innovation, presumably in the shape of neighbouring firms producing similar products.

Further, it seems particularly important that technology centres in Møre og Romsdal are not overly “research-oriented”, but are concerned with the transfer of already existing technology. Firms in the county largely carry out incremental innovation, and require assistance with the technological upgrading of products and processes, and with trial production and production start-up. They appear to have less need for advanced R&D services, although these are undoubtedly important to some firms. It is likely that these latter firms have the competence and resources needed to obtain such information from national or international R&D milieus.

Firms in Møre og Romsdal (as in Finnmark) experience difficulty in obtaining capital to finance innovative activity, and in obtaining highly qualified personnel. In addition, there is little motivation amongst local youth to qualify themselves as skilled workers, particular in the furniture industry. Thus in Møre og Romsdal too, there is need for traditional regional policy tools such as capital support and support for the recruitment and training of labour.

3) Central areas

The last area type is made up of central regions where there is a many-sided industrial base. These areas have relatively high levels of innovative activity. In the most central areas, the high level of innovative activity reflects large numbers of firms in innovative industries. Firms in these areas, and in particular in cities, make most use of R&D in the innovation process, and often obtain information from basic-research institutes. Innovation activity in these areas is most often directed towards radical innovation.

When policy-making is based on a view of “a comprehensive regional policy” (St.meld. nr. 33 (1992-3)), innovation policy in central areas should target fields where these areas have distinct advantages over other areas of the country. As central areas contain most Norwegian R&D institutions, it may be important to stimulate contact between such institutions and business.

One method of increasing contact between research and business is to establish technology parks, such as the technopoles in France, or innovation centres in Germany (Isaksen 1995). Only firms considered to be high-tech may locate themselves in such technology parks, and some parks are specialised within certain sectors. The aim of such technology parks is to locate research institutes, universities and firms together, in order to increase synergy effects through daily contact. Technology parks offer certain services, such as consultancy and administrative services. Such parks may be established by local or regional authorities, but also by, for example, universities or research institutes.

Technology parks such as these are most relevant for central areas where universities, colleges and other R&D institutes are to be found. Technology parks differ from the technology centres discussed above in connection with area-types 1 and 2. These parks are concerned with the commercialisation of new research results, whilst technology centres are mostly concerned with transferring already-existing technology to small and medium-sized firms.

Another relevant policy in central areas may be to foster the growth of spin-offs from R&D institutions. Often, new firms in new industries in Norway, such as the computer and electronics industries, have been established by persons who have worked in research institutes (Isaksen 1990b). In such cases knowledge gained about a new technology has provided the basis for the establishment of a new company. Such developments will occur most frequently in cities, where the majority of basic-research institutes are located. Technology parks can also promote this kind of development, by offering subsidised rents and investment support for new firms. A special programme from the Norwegian Research Council also intends to increase the number of R&D innovations and start-ups, where the target group is researchers.

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Fax: +47 2242 9533
Web: http://www.step.no/

STEP-gruppen ble etablert i 1991 for å forsyne beslutningstakere med forskning knyttet til alle sider ved innovasjon og teknologisk endring, med særlig vekt på forholdet mellom innovasjon, økonomisk vekst og de samfunnsmessige omgivelser. Basis for gruppens arbeid er erkjennelsen av at utviklingen innen vitenskap og teknologi er fundamental for økonomisk vekst. Det gjenstår likevel mange uløste problemer omkring hvordan prosessen med vitenskapelig og teknologisk endring forløper, og hvordan denne prosessen får samfunnsmessige og økonomiske konsekvenser. Forståelse av denne prosessen er av stor betydning for utformingen og iverksettelsen av forsknings-, teknologi- og innovasjonspolitikken. Forskningen i STEP-gruppen er derfor sentrert omkring historiske, økonomiske, sosiologiske og organisatoriske spørsmål som er relevante for de brede feltene innovasjonspolitikk og økonomisk vekst.

The STEP-group was established in 1991 to support policy-makers with research on all aspects of innovation and technological change, with particular emphasis on the relationships between innovation, economic growth and the social context. The basis of the group's work is the recognition that science, technology and innovation are fundamental to economic growth; yet there remain many unresolved problems about how the processes of scientific and technological change actually occur, and about how they have social and economic impacts. Resolving such problems is central to the formation and implementation of science, technology and innovation policy. The research of the STEP group centres on historical, economic, social and organisational issues relevant for broad fields of innovation policy and economic growth.