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Location, agglomeration and innovation: Towards regional innovation systems in Norway?

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Preface

This report is a slightly revised version of a paper presented at the Symposium of the Commission of the Organisation of Industrial Space, the 28th International Geographical Congress, The Hague, The Netherlands, August 5-10, 1996. A shortened version of the report will be published in European Planning Studies in 1997.

The theoretical part of the report examines the concept of regional innovation systems on the background of modern theories of innovation. The view of interactive learning as a fundamental aspect of the innovation process provides the ground for an interactive innovation model, which is greatly facilitated by geographical proximity and territorial agglomeration. The empirical part of the report analyses geographical variations in innovation activity in Norwegian industry. In this part we also identify different types of industrial agglomerations in Norway, and tries to measure international competitiveness, job growth and innovative activity in these agglomerations compared with corresponding industrial sectors nationwide, and also examining more thoroughly innovation performance in two industrial agglomerations in Norway, Horten and Jæren. On the basis of the theoretical clarification and empirical analyses carried out, the article finally discuss how to design a regional innovation policy for three main area types in Norway.

Table of contents

1. Introduction: Localised or placeless learning?

In the perspective of a "learning economy" as well as in modern innovation theory, learning is emphasised as a localised, and not a placeless, process (Lundvall and Johnson 1994; Storper 1995a). This view is supported by Porter, who argues that "competitive advantage is created and sustained through a highly localised process. Differences in national economic structures, values, cultures, institutions, and histories contribute profoundly to competitive success" (Porter 1990, 19). Accordingly, Porter argues that "the building of a "home base" within a nation, or within a region of a nation, represents the organizational foundation for global competitive advantage" (Lazonick 1993, 2). In contrast to this, Reich in his book "The Work of Nations" (1991) argues that "the globalization of industrial competition has led to a global fragmentation of industry, thus making national industries and the national enterprises within them less and less important entities in attaining and sustaining global competitive advantage" (Lazonick 1993, 2). According to Reich, "the work of nations" is the result of activities that take place in the national territory, and not of nationally-based companies (Reich 1991; Storper 1995b).

Storper considers the views of Reich and Porter, respectively, as "two widely differing analyses of how policy could implement a learning economy. One (Reich) can be characterised as "global economy + the generic public good of labor" and the other (Porter) as "national economy + the specific public good of technology". The first leads to broadly-based competitiveness policies; the second leads to more focused technology policies" (Storper 1995b, 291-92). Thus, Porter, on the one hand, focuses on the importance of "disembodied knowledge" in promoting innovativeness and competitiveness, i.e. knowledge and know-how which are not embodied in machinery, but are the result of positive externalities of the innovation process. Reich, on the other hand, points to "embodied knowledge" as the most important factor for securing a nation's future prosperity, i.e. knowledge embodied in production equipment (hardware), which can be operated on the basis of universal codified knowledge with a general, global accessibility (software). Reich particularly stresses the role of the quality of the work force, arguing that human capital investment is the most efficient public policy for attracting high-wage and high-value-added activities, demanding high-skill labour, to advanced nations from the "global webs" of trans-national corporations (TNCs) (Lazonick 1993, Reich 1991, Storper 1995b).

However, Reich's analysis partly misses the historical and contemporary importance of territory specifically (i.e. location and agglomeration) and non-economic factors (i.e. institutions, social structures, traditions etc.) in general, or in Piore and Sabel's words, the "fusion" of the economy with society (Piore and Sabel 1984), for the performance of an economy. Moreover, Reich's policy does not look especially promising from the point of view of keeping advanced, high-cost, welfare economies on a high wage/high innovation development path, taking into consideration contemporary developments in the global economy such as the rapidly increasing competitive advantage of Indian soft-ware industry, based on low paid civil engineers, and the heavy investments in higher education (especially applied science such as information technology) in countries like South Korea and Taiwan.

Thus, the most viable alternative for advanced, welfare states seems to be a policy of strong competition (Storper and Walker 1989), i.e. a competition building on innovation in contrast to weak competition based on price competition, on the assumption that localised learning, in industrial clusters and territorial agglomerations, represents the best framework for an innovative economy. The growing interest in the role of (especially) national, but also (increasingly) regional innovation systems must be understood in this context, i.e. as a policy instrument aiming at a systematic promotion of localised learning processes in order to secure the innovativeness and competitive advantage of an economy (Freeman 1995).

In this paper we shall focus on the regional level, arguing that "it is an essential level at which technological synergies are generated and to which any national technology policy must therefore be addressed" (Storper 1995a, 896). The increased concentration on regional innovation systems is partly a result of empirical development tendencies in the global economy, i.e. on the one hand the globalisation processes and the power of TNCs, and on the other hand, the "countervailing power" of regionalisation processes represented by the rapid growth of "new industrial spaces". It is also partly a result of a new theoretical understanding of the innovation process as basically a social process (from institutional economics), and of industrialisation as basically a territorial process (from economic geography) (Asheim 1995).

However, the combined effect of a globalised and de-regulated world economy, dominated by TNCs, and the reduced power of nation-states due to a transfer of authority to supranational organisations (e.g. the EU and WTO) is a shift in the regime of international trade relations from comparative advantage on the basis of relative best access to, and most efficient use of, "natural" production factors to socially produced competitive (absolute) advantage. On the sub-national, regional level this will lead to a polarised development of increased differentiation in innovation and economic growth between successful and unsuccessful regions, thus making the innovative capacity of firms and regions of strategic importance in determining regional futures. In the context of the challenges of increased competition between regions and, consequently, the need for restructuring, there will be a growing demand for a systemic public-private cooperation at the regional level, in the form of regional innovation systems for example, in order to achieve a sufficient level of innovativeness and competitiveness.

According to Storper, the geography of learning is made up of three basic elements (Storper 1995a), which will be examined in the paper. The first element will be dealt with in a theoretical analysis of the degree to which learning processes could be expected to be concentrated in nations and (especially) regions, emphasising that "underlying the innovation process is, by definition, a learning process" (Lazonick and O'Sullivan 1995, 4). Both the second and the third elements will be addressed in an empirical analysis of the geographical variations in innovative activity in Norway, trying to show where innovation occurs and its impact on the competitive advantage of regions. The analyses will be concluded by relating the discussion to the actual and potential existence of regional innovation systems in Norway, as part of a more general regional innovation architecture, and to their possible effect on promoting regional economic development

2. Theoretical perspectives

2.1 Localised learning and territorial agglomeration

The major effect of Porter's book "The Competitive Advantage of Nations" (1990) has been to change our understanding of the strategic factors which promote innovation and economic growth. Porter's main argument is that these factors are a product of localised learning processes, and that the importance of clusters is that they represent the material basis for an innovation based economy, which is viewed as "the key to the future prosperity of a nation" (Lazonick 1993, 2).

Porter's cluster is basically an economic concept indicating that "a nation's successful industries are usually linked through vertical (buyer/supplier) or horizontal (common customers, technology etc.) relationships" (Porter 1990, 149). However, he emphasises that "the process of clustering, and the interchange among industries in the cluster, also works best when the industries involved are geographically concentrated" (Porter 1990, 157).

These ideas are more or less the same as those Perroux, another Schumpeterian inspired economist, presented in the early 1950s. Perroux argued that it was possible to talk about "growth poles" (or "development poles" at a later stage in his writing) in "abstract economic spaces" defined as a "plan" (the vertical relationships of a production system) as well as a "homogenous aggregate" (the horizontal relationships of a branch), i.e. firms which are linked together with an innovative "key industry" to form an industrial complex. According to Perroux, the growth potential and competitiveness of growth poles can be intensified by territorial agglomeration (Haraldsen 1994; Perroux 1970).

In contrast to regional economic theory, Marshall attaches a more independent role to agglomeration economies. The "Marshallian" view of the basic structures of industrial districts presents the idea of "embeddedness" as a key analytical concept in understanding the workings of the districts (Granovetter 1985). It is precisely the embeddedness in broader socio-cultural factors, originating in pre-capitalist civil societies, that represents the material basis for Marshall's view of agglomeration economies as the specific **territorial** aspects of geographical agglomerated economic activity (Asheim 1992, 1994).

In both conventional and Schumpeterian-based regional economics, agglomeration economies are understood as agglomerated external economies, normally specified as "localisation" and "urbanisation" economies respectively, i.e. it is used as a **functional** concept describing an intensification of the external economies of a production system by territorial agglomeration (Perroux and Porter's use of the concept for example). In Marshall's view, external economies are obtained through the geographical concentration of groups of vertically and horizontally linked small firms (i.e. "localisation" economies). In regional economic theory, the achievement of external economies of scale is not conditioned by a territorial agglomeration of industrial complexes (i.e. Perroux's "growth pole"). Thus, by defining agglomeration economies as social and territorial embedded properties of an area, Marshall abandons "the pure logic of economic mechanisms and introduces a sociological approach in his analysis" (Dimou 1994, 27). Harrison emphasises that this mode of theorising is fundamentally different from the one found in conventional regional economics or in any other neoclassical-based agglomeration theory (Harrison 1991).

Thus, the main argument for territorial agglomeration of economic activity in a contemporary capitalist economy is that it provides the best context for an innovation based economy. In general, "geographical distance, accessibility, agglomeration and the presence of externalities provide a powerful influence on knowledge flows, learning and innovation and this interaction is often played out within a regional arena" (Howells 1996, 18). And more specifically, "agglomerated learning capability becomes a condition for both dominating the relevant global economic networks **and** securing the cumulative industrial development of the "home base", by attracting and supporting the best quality domestic and overseas firms" (Amin and Thrift 1995, 12).

2.2 Territorial agglomeration, innovation and competitive advantage

The importance of territorial agglomerations in promoting innovations concerns largely **incremental** innovations. This is especially the case when regional economies are dominated by clusters of SMEs. By contrast, Perroux's "growth/development pole" represents an exception, as the "key industry" by definition is a large firm with higher innovative capacity compared to the smaller firms in the pole, thus being able to carry out **radical** innovations. Even if such incremental innovations have no major individual impact, their combined effect can be extremely important for product design and productivity growth in different branches, especially in relation to the overall economic performance of SMEs. Freeman underlines "the tremendous importance of incremental innovation, learning by doing, by using and by interacting in the process of technical change and diffusion of innovations" (Freeman 1993, 9-10).

However, in an increasingly globalised world economy it is rather doubtful whether incremental innovations will be sufficient to secure the necessary competitiveness of territorially agglomerated SMEs. Crevoisier argues that the reliance on incremental innovations "would mean that these areas will very quickly exhaust the technical paradigm on which they are founded" (Crevoisier 1994, 259). Thus, most observers seem to agree that technological capabilities and the endogenous innovative capacity of territorially agglomerated SMEs, are important differentiating factors for the path of their future development (Asheim 1994, 1996). More specifically, this means the capability to break path dependency and change technological trajectory through radical innovations, so as to avoid falling into "lock-in situations" as a result of "weak competition" from low cost producers. Porter argues that "geographic concentration does carry with it some long-term risks, however, especially if most buyers, suppliers, and rivals do not operate internationally" (Porter 1990, 157), and Grabher points out what he calls an "embeddedness dilemma" with respect to major social, economic and technological changes (Grabher 1993). According to Varaldo and Ferrucci (with reference to industrial districts), "long-term strategic relationships, R&D investments, engineering skills, new technical languages and new organizational and inter-organizational models are needed for supporting these innovative strategies in firms in industrial districts" (Varaldo and Ferrucci 1996, 32).

Traditionally, the alternative of SMEs has been to introduce (more) formal R&D-based product and process innovations in order to upgrade innovative capability. The problem with this strategy, however, has been that formal R&D activity has normally been out of reach for the majority of SMEs due to lack of financial as well as human resources. In addition, the rapid growth of territorially agglomerated SMEs (e.g. industrial districts in the "Third Italy") based on flexibility, networks, and vertical disintegration of the production process, all imply "a far more complex structure to technological innovation" (Felsenstein 1994, 73).

Thus, "it is now recognized that technological innovation and its contribution to economic growth is punctuated by discontinuities, nonappropriabilities, and process of learning by doing, using and failing. Evolutionary theories of economic and technological change have now replaced the determinism of the linear model" (Felsenstein 1994, 73). This criticism of the traditional linear model of innovation as the main strategy for national R&D policies implies a broader view of the process of innovation as a technical as well as a social process; as a non-linear process, "involving not just research but many related activities" (Smith 1994, 6); and as a process of interaction between firms and their environment (Smith 1994).

The **linear model of innovation** was part of the Fordist era of industrial organisation and production[1], based on formal knowledge generated by R&D activity (i.e. codified scientific and engineering knowledge), large firms and national systems of innovation. Smith (1994) identifies two problematic areas of this model. The first problem was "an overemphasis on research (especially basic scientific research) as the source of new technologies" (Smith 1994, 2). Within this perspective a low innovative capacity could be explained by a low R&D activity. Consequently, technology policy in most western countries was directed towards increasing the level of basic research. The second problem was a "technocratic view of innovation as a purely technical act: the production of a new technical device" (Smith 1994, 2). The linear innovation model is, thus, "research-based, sequential and technocratic" (Smith 1994, 2).

Modern innovation theory implies a more sociological view of the process of innovation, in which interactive learning is looked upon as "a fundamental aspect of the process of innovation" (Lundvall 1993, 61). Lundvall emphasises that "learning is predominately an interactive and, therefore, a socially embedded process which cannot be understood without taking into consideration its institutional and cultural context" (Lundvall 1992, 1). Also, Camagni emphasises that "technological innovation ... is increasingly a product of social innovation, a process happening both at the intra-regional level in the form of collective learning processes, and through inter-regional linkages facilitating the firm's access to different, though localised, innovation capabilities" (Camagni 1991, 8). Thus, this alternative model could be referred to as a bottom-up **interactive innovation model**, much more adapted to SMEs in territorially agglomerated networks and the post-Fordist "learning

[1] Fordism is here defined as "an allegedly hegemonic form of industrial organization" (Sayer 1992: 194).

economy”, where **knowledge** is the most fundamental resource and **learning** the most important process (Lundvall and Johnson 1994). The interactive innovation model puts emphasis on “the plurality of types of production systems and of innovation (science and engineering is only relevant to some sectors), “small” processes of economic coordination, informal practices as well as formal institutions, and incremental as well as large-scale innovation and adjustment” (Storper and Scott 1995, 519).

Table 2.1 provides a summary of characteristics of the two innovation models

Table 2.1: Characteristics of two innovation models

	Linear innovation model	**Interactive 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

2.3 Innovation in a “learning economy”

Lundvall and Johnson use the concept of a “learning economy” when referring to the contemporary post-Fordist economy dominated by the ICT (information, computer and telecommunication)-related techno-economic paradigm (Lundvall and Johnson 1994). In addition to the combined effect of widespread ICT-technologies and flexible production methods, the learning economy is firmly based on “innovation as a crucial means of competition in the new techno-economic paradigm” (Lundvall and Johnson 1994, 26).

One of the consequences of the considerably more knowledge-intensive modern economy is that “the production and use of knowledge is at the core of value-added activities, and innovation is at the core of firms’ and nations’ strategies for growth” (Archibugi and Michie 1995, 1). Thus, in a learning economy “technical and organisational change have become increasingly endogenous. Learning processes have been institutionalised and feed-back loops for knowledge accumulation have been built in so that the economy as a whole ... is “‘learning by doing”’ and “‘learning by using”’“ (Lundvall and Johnson 1994, 26).

At the regional level the challenge is to increase the innovative capacity of (especially) SMEs by identifying “the economic logic by which milieu fosters innovation” (Storper 1995c, 203). Generally, it is important to underline the need for "enterprise support systems, such as technology centres or service centres, which can help keep networks of firms innovative" (Amin and Thrift 1995, 12). The best example of this form of support is provided by the "centres of real services" in the industrial districts of Emilia-Romagna (Brusco 1992), which have turned out to be successful in modernising the economic structure of the districts and, thus, have strengthened their competitive advantage. Furthermore, the formation of innovation networks between territorial agglomerations and the external world (Camagni 1991), giving priority to horizontal inter-firm technological cooperation to ensure the adoption and diffusion of radical innovations, is very important. According to Camagni, innovation networks with external and specialised milieus may provide local firms with "the complementary assets they need to proceed in the economic and technological race" (Camagni 1991, 4).

However, as underlined by Bellandi (1994) and Brusco (1990) it is a question of a potential collective innovative capacity, which has to be systematically developed and supported both at the intra-firm, the inter-firm and the regional level. This perspective emphasises the importance of organisational (social) and institutional innovations to promote cooperation, primarily through the formation of dynamic flexible learning organisations within firms, between firms in network and between firms and society regionally. In a learning economy the competitive advantage of firms and regions is based on innovations, and innovation processes are seen as socially and territorially embedded, interactive learning processes. Thus, in the perspective of new theories of innovation and endogenous growth, it could be argued that regions dominated by (territorial agglomerated) SMEs can develop a large innovative capacity as a basis for an endogenous regional development.

The question of a possible endogenous regional development highlights the importance of disembodied technical progress, i.e. progress "which can occur independently of changes in physical capital stock" (de Castro and Jensen-Butler 1993, 1), and "untraded interdependencies", i.e. "a structured set of technological externalities which can be a **collective asset** of groups of firms/industries within countries/regions" (Dosi 1988, 226), in addition to Marshallian agglomeration economies.

Marshall underlines that "a man can generally pass easily from one machine to another; but that the manual handling of a material often requires a fine skill that is not easily acquired ...: for that is characteristic of a special industrial atmosphere", which "cannot be moved" (Marshall 1919, 287, 284). According to de Castro and Jensen-Butler "rapid disembodied technical progress requires ... a high level of individual technical capacity, collective technical culture and a well-developed institutional framework ... (which) ... are highly immobile in geographical terms" (de Castro and Jensen-Butler 1993, 8).[2] Finally, Dosi argues that "untraded interdependencies" represent "context conditions" which generally are country- or region-specific, and of fundamental importance to the innovative process (Dosi 1988, 226). Amin and Thrift carefully underline "the role of localised "'untraded interdependencies"' in securing learning and innovation advantage in inter-regional competition" (Amin and Thrift 1994, 12).

[2] Lundvall and Johnson also emphasise that "the institutional characteristics of the learning economy becomes a crucial question" (Lundvall, Johnson 1994, 30).

Thus, the combination of territorially embedded Marshallian agglomeration economies, disembodied technical knowledge and “untraded interdependencies” could constitute the material basis for a new form of **comparative** advantage for regions in the globalised world economy. As Storper points out, “skilled labor of the type Reich cites is often quite firm-, and even product-specific. Moreover, technologies do not stand still; they have evolutionary properties, developing along trajectories whose shape and velocity are outcomes of actions taken by participating firms and other agents” (Storper 1995b, 293). It is an important object for regional innovation systems to integrate the traditional, “contextual” knowledge of the regions and the codified knowledge of the global economy in an attempt to promote endogenous regional development.

2.4 What is a regional innovation system?

Basically, an innovation system consists of a **production structure** (techno-economic structures) and an **institutional infrastructure** (political-institutional structures). According to Lundvall a distinction can be made between a narrow and a broad definition of an innovation system respectively: “The narrow definition would include organisations and institutions involved in searching and exploring - such as R&D departments, technological institutes and universities. The broad definition ... includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring - the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place” (Lundvall 1992, 12). The narrow definition can be associated with the **linear** model of innovation, while the broad definition incorporates the elements of a **interactive** innovation model.

Innovation systems are normally referred to as **national** systems, since “national differences and boundaries tend to define national innovation systems, partly intentionally, partly not” (Nelson and Rosenberg 1993, 16). The intentional aspects are related to the specific characteristics of a nation’s political-institutional system as well as the effect of a country-specific industrial and technology policy on a nation’s production structure. Comparative analyses of national innovation systems have shown the specificity of such systems due to different dominating branches of a country (Gregersen et al 1994). In addition, the existence of national standards and regulations makes domestic R&D cooperation more efficient, and public procurement policies can also support national R&D activity. The unintentional aspects defining national innovation systems are associated with the facilitating effects represented by common historical experiences, language and culture, and the importance of geographical proximity between user and producer as well as between industry and the state (Lundvall 1992).

However, cooperation in R&D is becoming increasingly transnational as a consequence of the globalisation of the world economy and the dominating position of TNCs, and the transfer of power to supranational units, especially the active role of the EU in launching a technology policy to promote European champions. On the other hand, within a nation-state, there are differences in the innovation systems of individual sectors of an economy that the general definition of a national innovation system ignores. Thus, there is a need for a concept of a **sectoral** innovation system as a complement to a national innovation system, in order to grasp the specific technological change and innovation activity taking place between competitive firms within relatively homogenous sectors (Breschi and Malerba 1995; Nelson and Rosenberg 1993). This concept, therefore, relates primarily to the horizontal relationships of a branch (as defined by Perroux and Porter). Furthermore, the concept of **technological** systems has been introduced to focus on the specific technologies of clusters or growth poles of vertically and horizontally related firms (Carlsson and Stankiewicz 1991).

As already mentioned, alongside the focus on national innovation systems, there has been a new interest in the role of **regional** innovation systems in promoting the competitiveness of regional economies (Cooke 1995). According to Storper and Scott, "a new "heterodox" economic policy framework has emerged in which significant dimensions of economic policy at large are being reformulated in terms of regional policies" (Storper and Scott 1995, 513). This is partly the result of the economic success stories of territorially agglomerated clusters of SMEs (e.g. in the Third Italy), and partly the result of the new political initiatives towards a "Europe of regions", where the development prospects of the lagging regions of Europe in particular have been a great concern for the EU. Also academically, among researchers working within the fields of evolutionary/institutional economics, there is a heightened awareness of the importance of the regional level when formulating technology policies. Thus, Lundvall has argued that "regional production systems, industrial districts and technological districts are becoming increasingly important" (Lundvall 1992, 3), and Carlsson and Stankiewicz maintain that sometimes it seems more accurate to refer to a regional technological system (in their words) than to a national one "as high technological density and diversity are properties of regions rather than countries. They are the results of local agglomeration of industrial, technological and scientific activities" (Carlsson and Stankiewicz 1991, 115).

Until now the understanding of innovation systems has been closely linked to the linear model of innovation, which in turn is associated with the Fordist form of mass production (Andreasen et al 1995), or at least has been an important reference point in understanding innovative activity in the Fordist period (Henry et al 1995). According to Storper and Scott, almost all approaches to systems of innovation share "an emphasis on formal organizations, on scientific-engineering skills, and on the national level of policy" (Storper and Scott 1995, 519). Porter's industrial cluster is also basically a product of the linear model of innovation; his "diamond model" primarily refers to "the nation's stock of scientific, technical, and the market knowledge bearing on goods and services" (Porter 1990, 75), even if the mention of market knowledge and the broad approach of the "diamond model" in general reflects a recognition of the importance of non-R&D based knowledge on the competitive advantage of firms, regions and nations. This is, perhaps, most clearly exhibited in his emphasis on the positive externalities of a territorial agglomeration of industrial clusters, "because it elevates and magnifies the interactions within the diamond"" (Porter 1990, 131).[3]

[3] Perroux's growth/development pole is also based on the same ideas as the linear model of innovation, as it emphasise the importance of large, innovative firms in key industries in the "top-down" initiation and diffusion of innovative activity. However, the time of the original formulation of his theories (i.e. in the early 1950s) make this fully understandable.

So what should we understand by a regional system of innovation? Should every ""knowledge industry," consisting of universities, engineering schools, R&D laboratories of large companies, small R&D firms, government laboratories" (Carlsson and Stankiewicz 1991, 115) located in a particular region be part of the innovation system of that region?[4] Howells, in his discussion of regional systems of innovation, uses Lundvall's definition of a national innovation system to argue that "regions within nations can also display distinct or "'idiosyncratic"' systems of innovation which depart from the national norm and in turn be different from other regions" (Howells 1996, 6). According to Howells, the existence of regional innovation systems will depend on the degree of homogenity in regional structures associated with innovative activity (Howells 1996). Howells describes three dimensions which could be used to analyse the importance of regional innovation systems (Howells 1996, 6):

- the regional structure of government both in relation to its administrative set-up and in terms of legal, constitutional and institutional arrangements;
- the long term evolution and development of regional industry specialisation; and
- additional core/periphery differences in industrial structure and innovative performance.

In addition to these dimensions, the two alternative models of innovation, i.e. the **top-down linear** model and the **bottom-up interactive** model respectively, must be given consideration as they will clearly influence the relative importance of the three dimensions with respect to both the existence of regional innovation systems and as to what kind of systems it is possible to identify in different regions.

In most nation-states both the **techno-economic** structures (i.e. the production structure) and the **political-institutional** structures (i.e. the institutional infrastructure) are primarily **national** in character, thus constituting a **national innovation system**. However, in some countries the regional structure of government has an independent role to play, either because the respective countries are federal states such as Germany, or because of a weak national political system as in Italy. When Baden-Württemberg are successful in launching their own technology policy, this has very much to do with "the relative autonomy of the Land **vis-à-vis** the federal government, a room for manoeuvre which is the envy of many regional authorities outside Germany" (Morgan 1992, 163). In Emilia-Romagna, on the other hand, the local and regional authorities have also played an active role in supporting the competitiveness of the industrial districts although this has to do primarily with the weakness of the national government, since " Italian local governments, even without legislative and financial autonomy, can play an important role in modernizing the industrial system through initiatives which do not require vast sums of money but which identify and meet specific local needs thus filling any gaps present in the industrial innovation system" (Bianchi and Giordani 1993, 40).

[4] A similar formulation is used as a definition of local (i.e. regional) innovation systems by the FAST program of the EU as "dense local networks of enterprises, laboratories, higher education and financial institutions, and serve as localised channels for using, developing and diffusing available competencies, initiatives and innovation capabilities throughout the system" (Hingel 1994, 19).

However, the type of technology and innovation policies that have been proposed in Baden-Württemberg and Emilia-Romagna, respectively, are very different. While Baden-Württemberg has basically followed a linear innovation model, in which formal R&D carried out in technological institutions and universities plays the most important role, the innovation system in Emilia-Romagna is much more characterised by a bottom-up interactive model of innovation, where the local industry and local state in cooperation have effected learning and innovation.[5] Referring to Emilia-Romagna (in a comparison with Baden-Württemberg), Morgan maintains that "a much wider social constituency is involved in the regional innovation network" (Morgan 1992, 163). Generally, it can be argued that the interactive innovation model is less dependent on a formal governance structure than the linear model due to its bottom-up characteristics.

The same distinction can be made with respect to the question of regional industry specialisation. Here it is important to distinguish between a **sectoral** specialisation based on a **national** industry and technology policy on the one hand, e.g. a policy of growth pole-based industrial complexes in different regions related to the exploitation of natural resources, and a historically evolved, area-based specialisation such as the industrial districts of the Third Italy on the other hand. The major differentiating factors in play in these examples are not the techno-economic structures as such, but rather the importance of **non-economic** factors for the economic performance of regions. This is also in accordance with the new understanding of the institutional context of a "learning economy", where **socio-cultural** structures are not only looked upon as relics of pre-capitalist civil societies, but as necessary prerequisites for regions striving to be innovative and competitive in a post-Fordist global economy, and **socio-economic** structures represent the contemporary basis for the development of a "learning economy" (Amin and Thrift 1994, Grabher 1993, Lundvall 1992). According to Amin and Thrift, this forces a re-evaluation of " the significance of territoriality in economic globalisation" (Amin and Thrift 1995, 8). In contrast to the techno-economic and the political-institutional structures, the **socio-cultural** and the **socio-economic** structures are **territorially embedded**, and thus show considerable geographical variations within and between countries (Asheim 1990).

Howells points out that often "strong core/periphery hierarchical differences are apparent in terms of power, decision-making and innovative performance" (Howells 1996, 7). This can be the result of a high degree of concentration in the location of corporate headquarters, top-level government functions and other key decision-making activities in the core, while the periphery is dominated by branch-plants and traditional economic sectors with little or no innovative activity. However, differences in innovative activity can also be due to what is understood by innovation, i.e. if the standards of comparison are based on the linear or the interactive models of innovation. In most cases, industries located in the core will

[5] Cooke and Morgan point out that the success of Emilia-Romagna to a large extent is caused by the region's "capacity for collective entrepreneurship, i.e. the disposition to collaborate to achieve mutually beneficial ends. This is evident in the **corporate** realm, where it manifests itself in close inter-firm relations, strong business associations etc, and in the **political** realm, where a high premium has been placed on creating a robust and decentralised system of institutional support" (Cooke, Morgan 1994, 109).

show higher figures of formal R&D-activity, while in the periphery, this could be compensated for by relying on other forms of innovative activity, which, according to the interactive model of innovation, are important in promoting the competitiveness of firms and regions.

Thus, it would make more sense, analytically as well as politically, to distinguish between different types of regional innovation systems. On the one hand, we find innovation systems that are parts of a **regionalised** national innovation system, i.e. parts of the production structure and the institutional infrastructure **located** in a region, but **functionally** integrated in, or equivalent to, national (or international) innovation systems, which is based on a top-down, linear model of innovation. On the other hand we can identify innovation systems constituted by the parts of the production structure and institutional set-up that is **territorially** integrated or **embedded** within a particular region, and built up by a bottom-up, interactive innovation model.

Examples of a **regionalised** national innovation system could be the R&D laboratories of large firms, governmental research institutes or “science parks”, normally located in the proximity of technical universities and based on the thinking of the linear model of innovation, and with rather limited linkages to local industry (Asheim 1995, Henry et al 1995). This all implies a lack of territorial embeddedness and leads to questions about their capability for promoting innovativeness and competitiveness on a broad scale in local industries (especially the SMEs) in the particular regions, as a prerequisite for an endogenous regional development. However, there is a better networking between R&D-institutions, firms and the local state in regionalised national innovation systems than in national systems (i.e. the regional innovation system of Baden-Württemberg). (Cooke and Morgan 1994).

The best examples of territorially embedded, regional innovation systems are networking SMEs in industrial districts, which build their competitive advantage on localised learning processes. Thus, in Emilia-Romagna for example, the innovation system could be said to be territorially embedded within that particular region. The rationale for such territorially embedded systems is, therefore, to provide a bottom-up, network-based support (e.g. through technology centres, innovation networks or centres for “real services”) for the “adaptive technological and organizational learning in territorial context” (Storper and Scott 1995, 513). To be able to talk about a territorially embedded, regional innovation system the national, functionally integrated, techno-economic and political-institutional structures must be “contextualised” through interaction with the territorially embedded, socio-cultural and socio-economic structures (Asheim 1995).

However, different industries, in terms of branch, size and forms of organisation have different requirements of innovation systems. There are obviously differences in demand between locally controlled SMEs (including their subcontractors/suppliers) on the one hand, and large locally controlled firms (including their supply chains), subcontractors/suppliers for firms outside the region, and branch plants on the other hand. While the first category of firms primarily need the support of an interactive, regionally embedded innovation system, the last three categories of firms basically demand the services of a linear innovation model. The second category of firms, in addition to national and international innovation systems, can make use of a regionalised, national innovation systems. Depending on the branches of the firms, the services of a regionally embedded innovation system can also be used. Even in a R&D-dominated industry such as the petro-industrial complex, the mechanical firms of the offshore-industry can benefit from the broader view of interactive learning as central to innovative activities, and especially by exploiting the increased impact of a territorial agglomeration of a production system on the firms' international competitive advantage (see Table 2.2).

Table 2.2: Characteristics of the innovation system for different types of firm

Type of firm	**Type of production network**	**Important source of information for innovation activity**	**Type of innovation system**
Locally controlled SMEs (producing for the final market) and their subcontractors/ suppliers in local production systems	Regional, symmetrical	Other local firms + customers	Regional embedded
Large locally controlled firms and their supply chains (producing for the final market)	All geographical levels, symmetrical levels	Other local firms, customers + the R&D sector	Regional/ national/ international
Suppliers/ subcontractors for firms outside the region in national/international production systems	National/ international, symmetrical/ unsymmetrical	Customers	National/ international
Branch plants	National/ international, unsymmetrical	The owner company	National/ international

According to the alternative view presented, a regional innovation system cannot simply be seen as "a subset of a wider 'systems nest' relating to knowledge and innovation" (Howells 1996, 8). On the contrary, a territorially embedded, regional innovation system builds on different types of knowledge and views of innovative activities compared to the traditional system perspective. In addition to the informal, practical and tacit knowledge of "learning by doing" and "learning by using", which is the basis of embedded Marshallian "agglomeration economies", such learning processes depend on the important category of **localised, codified** knowledge (in contrast to codified knowledge of a universal character).[6]

Localised, codified knowledge can provide the basis for "learning by interacting" (e.g. user-producer relationships), which represents a more advanced form of learning than "learning by doing" and "learning by using", as it cannot primarily be based on tacit knowledge. According to modern innovation theory, interactive learning has the potential to produce **radical** innovations in addition to incremental ones. This specific kind of knowledge is the combined, "synergetic" result of

[6] Storper refers to this category as "knowledge and practice which is not fully codifiable" (Storper 1995b, 293).

disembodied technical knowledge, mastered by particular groups of firms "through networks, which include formal exchanges with other firms" (Storper 1995b, 293) and "untraded interdependencies" comprised of "labor markets, public institutions, and locally- or nationally-derived customs, conventions, and understandings, which enable the effective transmission of information and development of knowledge" (Storper 1995b, 293).[7] In this context it is important to emphasise that "whilst knowledge in the form of embodied technical progress can be exported independently of social institutions, such knowledge in its disembodied form cannot be absorbed independently of such institutions" (de Castro and Jensen-Butler 1993, 3). The rationale behind endogenous development is precisely "to use this social organization to generate innovation and economic development" (Lazonick and, O'Sullivan 1995, 4).

De Castro and Jensen-Butler (1993) argue that different types of innovation require different kinds of knowledge. Generally, **product** innovations represent a more "disembodied" form for technological development than process innovations, and **organisational** innovations will typically be conditioned by "disembodied" knowledge, as they normally are a product of intra- or inter-organisational learning processes. However, process innovations being developed through inter-firm cooperation within a region must be considered as an example of "disembodied" technological progress (Asheim 1993).[8]

The importance of "disembodied" knowledge for carrying out product and organisational innovations is especially interesting from the perspective of the promotion of endogenous regional development, as they are the most growth generating innovations. Product innovations are central to a strategy of "strong competition" in order to compete through product differentiation or shifts up the price-quality curve. Organisational innovations could be said to have been the most important innovations in the development towards increased flexibilisation of industrial production. Examples of such organisational innovations are the introduction of just-in-time principles, and the vertical disintegration process of industrial organisation. These organisational innovations have had a direct impact on innovativeness and competitiveness through increased interactive learning, as well as an indirect effect on firms' competitive advantage through a more efficient exploitation of process innovations, thus representing an "interaction between embodied and disembodied technical progress" (de Castro and Jensen-Butler 1993, 3).[9]

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[7] This important intermediate category of localised, codified knowledge is obviously missing in the following statement: "Although many parts of the innovation process can be codified and easily transferred over long distances, many elements of technological innovation remain tacit in form and indeed these may be the elements that have the most impact on corporate performance for the very reason that they are so difficult to learn "offsite" and to transfer to a different location" (Howells 1996, 16).

[8] For a concrete illustration of this, see Section 4.4 on the mechanical engineering cluster of Jæren, south of Stavanger (in the south-western part of Norway).

[9] In addition we must not forget that "embodied technical progress is also a source of economic growth" (de Castro, Jensen-Butler 1993, 3).

As emphasised then, the territorial dimension to innovation is important. The innovation process is in part based on resources that are place-specific, i.e. resources tied to particular places which cannot be copied or reproduced elsewhere. Regional conditions are seen as "contributor[s] to the creation of technology" (Courlet and Soulage 1995: 293). Therefore, there is "a stronger role for 'place' in... the innovation process" (Tödtling 1994: 68-9). Besides, innovative activity varies between regions, depending on the firm and industry structure, as well as on social and institutional conditions.

The question to be explored then is to what extent the level of innovative activity really varies between geographical areas, here exemplified by areas along a centre-periphery axis in Norway. Which areas of the country display the highest levels of innovative activity, and which areas have the lowest levels? And how does the innovation process occur in different areas? The answers to such questions represent significant knowledge when discussing how a regional innovation policy could be tailored to suit varying local conditions (Section 5).

3. Location and innovation

3.1 Geographical variation in innovative activity

The empirical data for the analysis derive from the Community Innovation Survey for Norway, carried out by Statistics Norway in 1993. The survey investigated innovative activity in Norwegian manufacturing industry, with nearly 1 000 responses.

Examining first the extent of innovative activity, two indicators are used: 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, while the second indicator provides us with a measure of the **results** of innovative activity.

The geographical variations are explored by classifying Norway into five different types of area according to a centre-periphery dimension[10]. Table 3.1 also displays a clear centre-periphery pattern. 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 an even spread of innovative firms throughout all area types, with the exception of the most peripheral areas. However we must underline that there are firms with some innovation costs to be found in these peripheral parts of the country. The relatively even spread of innovative firms may also reflect the definition of innovation in the Community Innovation Survey, which is more in accordance with the interactive than the linear innovation model. Thus, innovation costs cover costs associated with both R&D, product design, trial production and production start-up, the purchase of products and licenses, market analyses, other operating costs associated with innovation, as well as investment

[10] The five area types have been determined with the assistance of Statistic Norway's classification of communes according to centrality in 1990. City centres and city surroundings have the highest "centrality code" of 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. Only six settled areas came under this classification in 1990: Oslo, Kristiansand, Stavanger, Bergen, Trondheim and Tromsø. These six communes make up "city centres" in our classification (cf. Table 3.1), 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, and are the most peripheral located communes in Norway.

costs (machinery, equipment etc.) in connection with product and process innovations.

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

Table 3.1: 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 who have answered the questions regarding 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.

This finding of a relatively wide distribution of innovative activity is in line 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 have experienced significant losses in manufacturing jobs. The more peripheral areas of the country (smaller towns and rural areas) experienced growth in manufacturing jobs during the 1980s, and had well below average rates of decline during the 1990s. Various data suggest that job growth in non-central areas is often locally based (Isaksen 1996). It is reasonable to assume that the relatively positive developments in these areas reflects a certain innovative activity by firms. In the long-run, most firms cannot compete solely on the basis of the lower wage costs and regional subsidies in non-central areas, but must also develop new products and processes.

The geographical variations in the shares of innovative firms shown in Table 3.1 can in principle 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”; i.e. 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 represents 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.

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 3.1 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 already underlined, 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) [11].

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 3.1). 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 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 have relatively more innovative firms within the various sectors than the national average.

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 largest city-communes are not particularly innovative compared to the national average[12]. 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.

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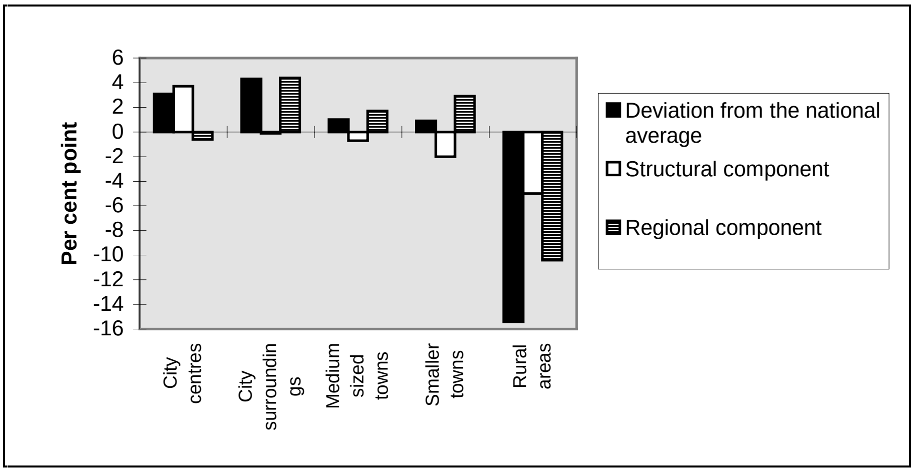
[11] Industrial structure alone is taken into account when calculating the structural component in Figure 3.1, but the same overall picture emerges when also considering different size structure of firms (Isaksen 1996). 18 sectors are used when calculating the structural component in Figure 3.1; oil extraction, mining, and 16 sectors at 2 and 3 digit level in the industrial code. The method used in this shift-share analysis is more thoroughly described in Isaksen (1996).

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

Figure 3.1: Share of firms with innovation costs 1992. Shift-share analysis by industrial structure



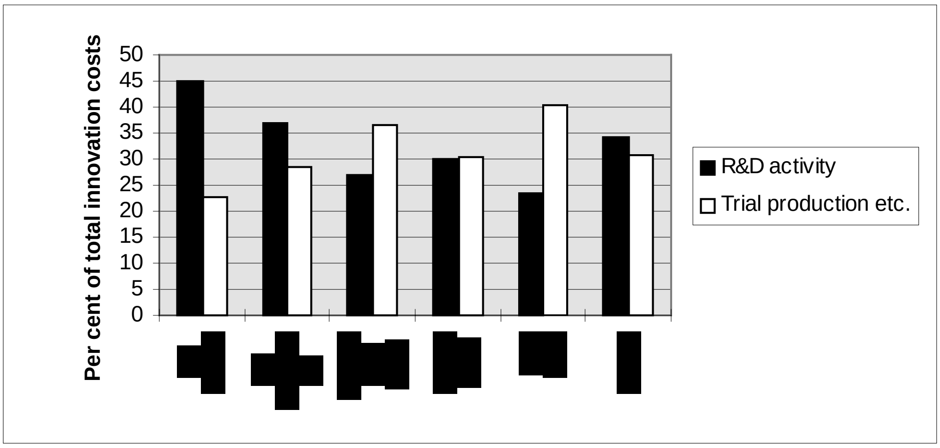
3.2 Innovation performance in different areas

After having shown the extent of innovative activity we will now examine more closely **how** innovation takes place in different areas. First, we present an overview of the different activities involved in the innovation process, before showing the sources of information for, and aims of, innovative activity.

A centre-periphery pattern emerges when examining the distribution of innovation costs between the two most important activities. In city centres R&D is far more important than in the country as a whole (Figure 3.2) 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[13]. 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. The results in Figure 3.2 witness that an examination of geographical variations in innovation activity based on the linear innovation model, where innovation activity is basically understood as R&D, would have shown a much more centralised pattern with most innovative activity occurring in central areas.

[13] R&D and trial production and production start-up are the two largest cost-components for all area-types, and are also the components that vary significantly between area-types, which are the reasons why these are the only two components shown in Figure 3.2.

Figure 3.2: Two kinds of innovation costs. 1992

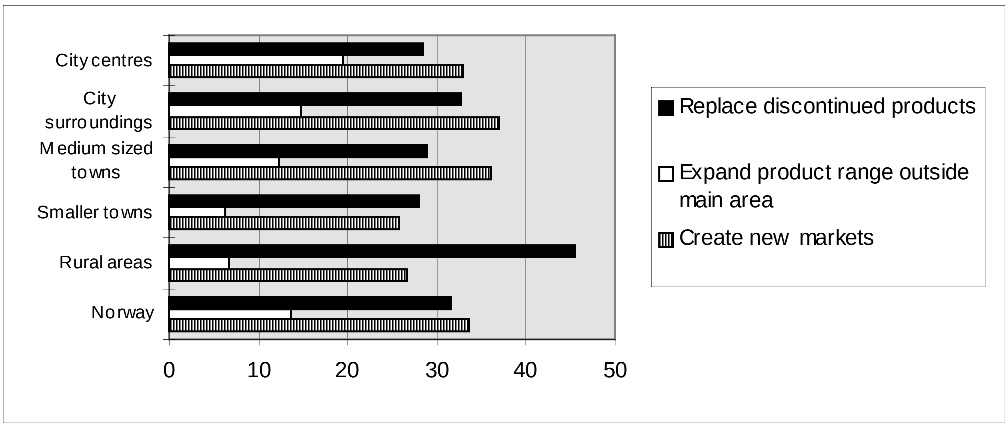


The fact that firms in central areas make most use of R&D may suggest that innovation processes in these areas are to a greater degree oriented towards **radical innovations** (new products and processes). Systematic research and development, and R&D competence are namely essential to this type of innovation (Freeman 1995). Further, the results suggest that **incremental innovations** (changes to already existing products and processes) are more important to the innovation process in less central areas, but also that firms in these areas “import” and alter innovations from outside (Isaksen 1996).

Figure 3.3 only partly confirms the intimation that innovation processes in central areas are more directed at radical innovations than in the rest of the country. The figure shows the importance of aims associated with radical innovations[14]. “Replacing discontinued products” emerges as a more important aim in rural areas than in the remainder of the country. However, the two other aims included in Figure 3.3 - “increasing product range outside of main areas of activity” and the “creation of new markets” - are considered important by the greatest number of firms in city areas and medium-sized towns.

[14] The Community Innovation Survey delineated 17 different sub-aims of firm’s innovation. Of these the aims to “replace discontinued products”, “expand product range outside main area of activity” and “create new markets” are placed in the category of radical innovation aims. The last indicator is split into four sub-aims in the innovation survey, namely to create new markets in Norway, the Nordic countries, EU and other countries respectively.

Figure 3.3: Share of firms which state that different aims have great or decisive importance for firm's innovation activity



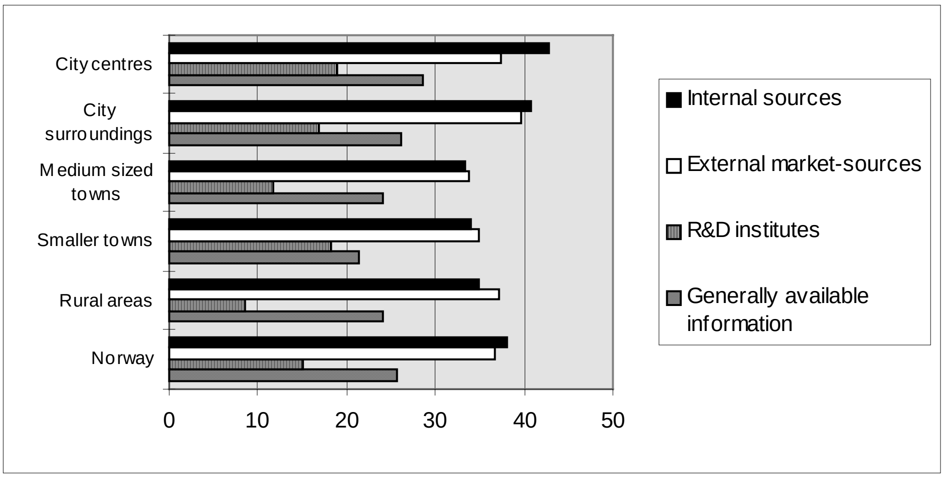
Lastly, looking at sources of information in the innovation process, firms employ a variety of external sources, in addition to the development of knowledge internally within the firm and company (Figure 3.4). Clients, together with suppliers of equipment and materials, are considered to be the most important sources of information by firms in the national innovation survey (Nås et. al 1994), and these are important to firms in all area-types. 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 innovation survey, is what Nås et. al. call the knowledge infrastructure, namely patent documents, consultants, universities and colleges, public research institutes and sectoral research institutes (Nås et. al. 1994). Thus, R&D institutes etc. are considered to be the least important source of information for innovative activity by firms in all area-types. Regional innovation policy often tries to link firms to different types of R&D institutions (Isaksen 1995). Such an approach may at first seems strange, considering that firms themselves see R&D institutions as the least important source of information (cf. Hassink 1996).

All in all the analyses clearly demonstrate that the interactive innovation model (described in Section 2.2) most accurately describes innovative activity in Norwegian manufacturing in the 1990s. The model concurs with important observations concerning the innovation process, i. e. that the innovation process incorporates many activities in addition to "pure" R&D, that firms innovate in co-operation with many other firms and institutions, and that innovation activity is relatively geographically widespread.

Taking a more thorough glance at the different information sources, a higher share of firms in city areas, and in small towns, consider R&D institutions to be important sources of information (Isaksen 1996). 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. 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. This difference between area-types partly reflects differences in industrial structure, and the fact that the R&D sector to a large degree is concentrated around Norway's university towns.

Figure 3.4: Share of firms answering that different main sources of information have great or decisive importance for firm's innovation activity



4. Agglomeration and innovation

The conception of innovation as partly a territorial phenomena is to a great extent based on the "success" of some specialised industrial agglomerations or regionally concentrated networks of mainly small and medium-sized firms, since the 1970s. During the last decades some specialised industrial agglomerations have established a strong position in the world marked for both more traditional products (e.g. Third Italy) and high technology products (e.g. Silicon Valley). Moreover industrial agglomerations have attracted great interest both by academics and policy makers, resulting in SMEs and networking being one of the main targets of industrial and regional policy in many industrialised countries since 1980 (Humphrey and Schmitz 1995).

There has been a considerable interest in the bases of the success in some of the specialised industrial agglomerations. As mentioned before, one argument emphasises territorial agglomerations as the best context for learning and innovation. Thus, according to Storper (1992) an increasing share of exports from nations originate from "technology districts". In these areas technological learning takes place, stimulating product innovations, and thus creating competitiveness as the basis for export. In the same way Porter (1990) points out that clusters "work best when the industries involved are geographically concentrated" (p. 157).

Thus, in some specialised industrial agglomerations there exist regional innovation systems. Firms co-operate in innovation, co-operation is promoted by the existence of social norms and mutual trust, and the innovation activity and the learning process is sustained by formal institutions, such as industrial service centres, technology centres and centres for labour training. However, specialised industrial agglomerations cannot be equated with regional innovation systems. In some industrial agglomerations, an extensive regional innovation system cannot be identified. This could, for instance, be the case when firms compete by low wages, (numerical) flexible use of labour and capacity subcontracting, and not by product and process innovations.

4.1 Areas of specialised production in Norway

The subsequent part of this paper attempts to identify different types of industrial agglomerations in Norway by use of extensive statistical material. How many specialised industrial agglomerations can be identified in Norway, and where are these located? And are firms in these agglomerations more innovative and more competitive than firms in corresponding industrial sectors elsewhere in the country?

Of course, one cannot identify specialised industrial agglomerations solely by means of quantitative data from official statistics. An understanding of the manner in which production is organised and innovation carried out in agglomerations requires more intensive surveys of individual firms. Consequently, the paper also analyses innovation activity in two specialised industrial agglomerations in Norway, based on extensive face-to-face interviews with firm managers and other informants.

Statistical material, however, makes possible comprehensive national analyses of **some aspects** of industrial agglomerations, and quantitative analyses can supplement the results from more qualitative case studies.

Specialised industrial agglomerations comprise a concentration of firms in particular sectors and localities. These are fairly small geographical areas (often labour market areas) with a high share of jobs (in relation to the national average) within one or several adjacent industrial sectors. Thus, a basis for identifying specialised industrial agglomerations is the division of Norway into 103 labour-market areas (or travel to work areas) and 39 industrial sectors[15]. In the first instance, specialised industrial agglomerations are delimited to labour-market areas where:

1. the locational quotient for an industrial sector is higher than 3.0, and where
2. there are at least 200 man years in the sector.

The locational quotient highlights the regional specialisation, i.e. which labour market areas have industries with at least three times as many jobs as “expected”, based on the industry’s significance on a national scale. The limit for the locational quotient at exactly 3.0 is based on estimation. Different limits have been tested, and a locational quotient of roughly 3.0 is seen as reasonable for our purpose (Isaksen and Spilling 1996). A lower limit of 200 man years is set, so as not to include many small agglomerations.

By applying these criteria it is possible to delimit 143 industrial agglomerations in Norway in 1990 with a total of just under 180 000 man-years. The agglomerations had approximately 20% of all man years in the country as a whole in those industries for which figures are available from the data source.

4.2 Industrial agglomerations and international competitiveness

Many of the identified agglomerations are to be found in industries where Norway has a high export rate, measured by the revealed comparative advantage index (OECD 1994). Revealed comparative advantage measures the country’s share of exports from each sector in relation to exports of all manufacturing sectors, and compared to the average in 13 OECD countries. For example, Norway has a revealed comparative advantage of more than 8.5 in shipbuilding (Table 4.1), meaning that Norway has eight and a half times as high a share of export coming from shipbuilding than the average of the OECD countries.

[15] The data source (the Central Register of Establishments and Enterprises at Statistics Norway) provides figures for all of industry except the primary industries and the public sector. The analyses utilize an adjusted three-digit industrial classification based on the Standard Industrial Classification in Norway. Manufacture is, for example, divided into 20 sub-groups.

A major weakness with this type of analysis is that we can only study the situation and the development in the statistically defined industrial sectors, and not in production systems which cut across sectors. Firms in the dominant sector or sectors in industrial agglomerations may have subcontractors in many different sectors, but this cannot be taken into consideration with this type of statistical analysis.

Table 4.1 displays the industries where Norway has a revealed comparative advantage higher than one. These are the industries where Norway has a higher share of exports than the OECD average. There are two important observations to be made:

1. The sectors where Norway has a high comparative advantage are at the same time sectors with many industrial agglomerations, identified by the above mentioned criteria. 90 of the 124 agglomerations in manufacturing are in these sectors, which is an overrepresentation, as these sectors have one third of the number of manufacturing jobs in Norway. Thus, Norway's export specialisation industries tend to agglomerate.
2. In the same sectors, the agglomerations increased their share of all jobs in these sectors between 1970 and 1990. In shipbuilding, for instance, the agglomerations increased their share of all jobs in this sector in Norway from about 30 to 60%.

Table 4.1: Industrial sectors in Norway with revealed comparative advantage higher than 1,0, and information on specialised industrial agglomerations in these sectors

			Share of all jobs in the sectors to be found in the agglomerations	
Industrial sectors	Revealed comparative advantage	The number of industrial agglom. in 1990	1970	1990
Ships	8.57	12	31.6	60.6
Petroleum refining	4.55	3	48.4	78.4
Basic metals	3.91	30	74.0	78.4
Pulp and paper	2.03	8	55.9	74.4
Wood products	1.37	9	25.2	34.9
Furniture	1.37	5	22.8	34.1
Food (i.e. fish)	1.35	14	55.1	65.9

Thus, many agglomerations appear competitive; they have a relatively high export rate, and they increase their share of all jobs in the export specialisation sectors. Does Table 4.1 give a "statistical proof" of spatial clustering leading to higher international competitiveness? In Norway, most of the industrial sectors with a high export rate are resource intensive industries. The basis for competitiveness is raw materials such as oil and gas, fish, wood and large amounts of hydro electric power, although high competencies are created in research and development in many of these industries in national institutions (Reve et. al. 1992), contributing to the formation of national innovation systems. This implies that industrial agglomerations have developed because Norway has resources as the basis for exports. In addition, most of the identified agglomerations in petroleum refining, basic metals and pulp and paper have one or only a few firms in these industries, signifying that horizontal co-operation between *local* firms is not the basis for the competitiveness in these agglomerations.

In the other sectors in Table 4.1, where the industrial agglomerations most often have many firms in the same sectors, spatial clustering of firms may be one important base for competitiveness and export. We cannot, however, verify if and how international competitiveness is created in agglomerations by means of statistical analyses. However, the case of Horten and notably Jæren, described afterwards, demonstrate that co-operation between local firms and institutions have formed the basis for innovation activity and competitiveness in some cases.

4.3 Innovative activity in industrial agglomerations

The industrial agglomerations most noticed in the literature as "innovative milieus" are characterised by many (often small and medium sized) firms, forming local production systems, which comprise subcontracting and horizontal co-operation between firms and between firms and local institutions. It is not possible to delimit this kind of agglomeration using only statistical data. Nevertheless to carry the analysis one step further, we can introduce two more criteria:

1. The industrial agglomerations must have 10 or more establishments in the dominant industrial sector. This criteria takes away one-company towns, most often dominated by basic metal firms and firms in pulp and paper, petroleum refining and chemical production, and the criteria gives a potential for local horizontal co-operation between firms in the same industries.
2. The industrial agglomerations must be dominated by industrial sectors where vertical disintegration of the production chain may occur. Vertical disintegration is one important characteristic of the agglomerations which has received much attention since the 1970s (Henry 1992). Disintegration means that a local subcontracting system can arise and that the firms can achieve external flexibility.

By applying these two criteria, it is possible to delimit 41 agglomerations with 54 300 man years in **manufacturing industries** and three agglomerations in **producer services** with just over 33 700 man years in 1990 (cf. Isaksen and Spilling 1996). In most sectors these agglomerations have a distinct geographical location (Map 4.1). The area in and around the capital of Oslo has three agglomerations in the electronics (and electrical industry) and producer services, respectively, and the only one in the country in printing and publishing. These are large agglomerations in the number of jobs, signifying that about 68% of the jobs in these kind of agglomerations are found in city-areas, and another 17% in medium sized towns (Figure 4.1).

The south-eastern part of Norway has seven agglomerations in mechanical engineering, while there is also one important agglomeration in this industry in Jæren in the south-western part of Norway. The north-east has five agglomerations in wood products. Six agglomerations in shipbuilding are concentrated on the west coast in 1990, while the Oslo fjord area had two important agglomerations in this industry in 1970. The north-western part of Norway, more precisely the region named Sunnmøre, also has three agglomerations in furniture and two in textiles and clothing. Lastly, twelve agglomerations in fish processing are located along the western and northern coastline.

Map 4.1: The typical location of industrial agglomerations in different industrial sectors in Norway in 1990

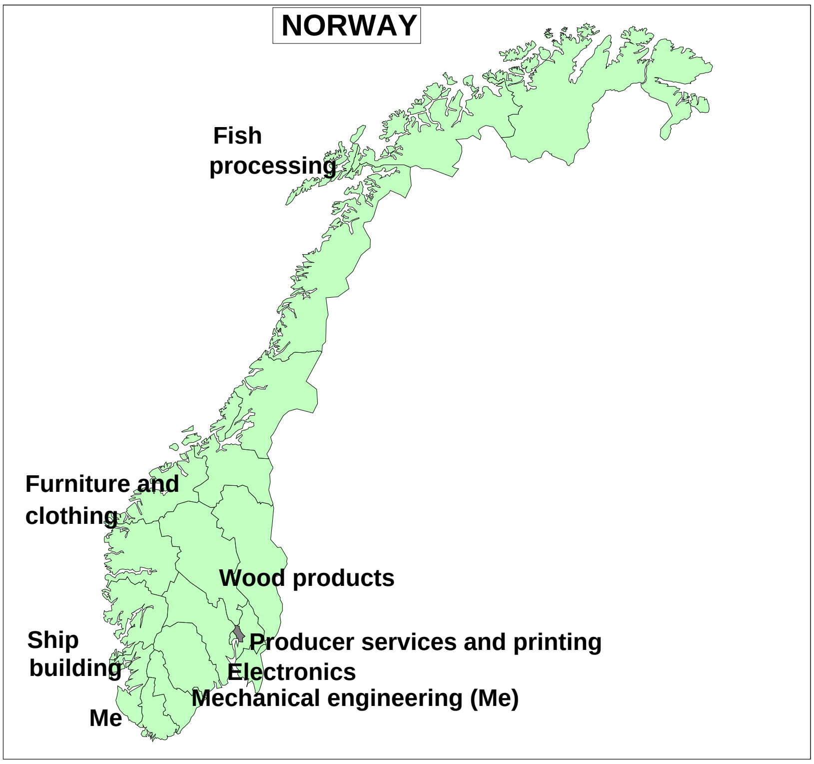
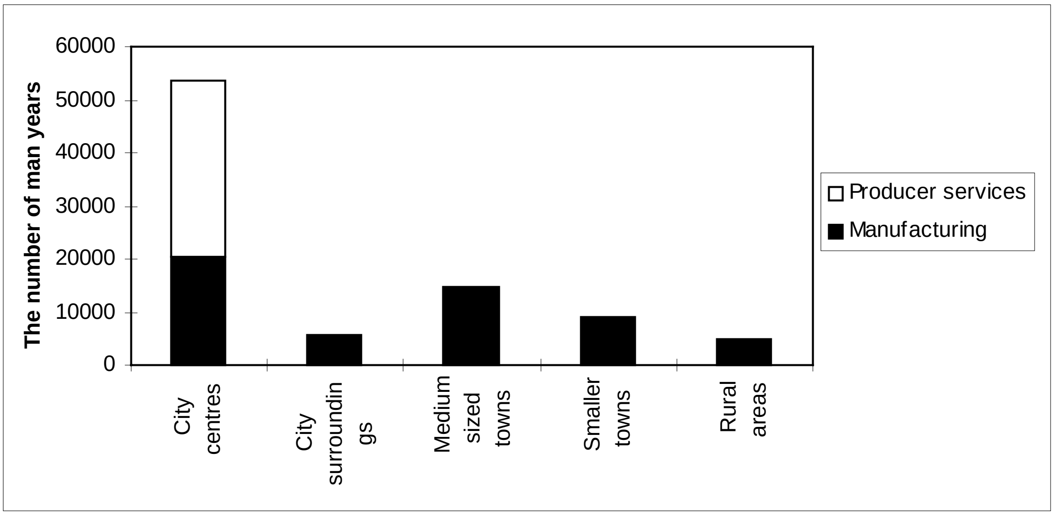


Figure 4.1: The number of man years in industrial agglomerations in different area-types



Finally, Table 4.2 shows the share of innovative firms in these industrial agglomerations. The Community Innovation Survey referred to in Section 3 provides information on 134 firms in the relevant sectors in the agglomerations, i.e., those sectors that constitute the specialisation of the area. The identified agglomerations 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 4.2, but the identified specialised industrial agglomerations appear to have at least as great a share of innovative firms as the national average. Taken together, Tables 4.1 and 4.2 offer some empirical support in the Norwegian case for the claim that territorial agglomerations provide good conditions for promoting innovativeness and competitiveness.

Table 4.2: Share of innovative firms in industrial agglomerations

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

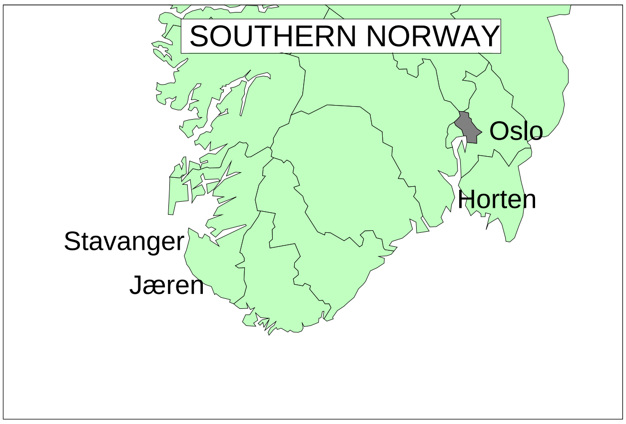
* Refers to number of firms with innovation costs.
** Share of firms with new or significantly altered products during the period 1990-92 in sale.

4.4 The mechanical engineering cluster of Jæren

Jæren is an industrial district south of Stavanger, in the county of Rogaland, in the south western part of Norway. The communes of Jæren are located within 75 minutes travelling distance from Stavanger, thus belonging to the category of “city surroundings” (Map 4.2). In 1992, Rogaland was the largest industrial county in Norway with a population of about 350.000, of which about 28.000 were employed in the manufacturing industry. The mechanical engineering sector, which dominates the industry at Jæren, had approximately 13.000 employed in 1992, with a turnover of about 12 billion NOK. The region of Jæren comprises almost 60% of the population in the county (incl. Stavanger), and has been the economically dominating part since World War 2.

At Jæren, an organisation called TESA (Technical Cooperation) was established by local industry in 1957, in collaboration with the local technical schools, with the aim of supporting technological development among the member firms, which are medium-sized, export-oriented firms producing mainly farm-machinery. This has, among other things, resulted in the district today being the centre for industrial robot technology in Norway with a competence within industrial electronics/microelectronics that is far above the general level in Norway. Furthermore, the use of industrial robots is much more widespread in this region than in the rest of Norway (i.e. ca. 1/3 of all industrial robots with only 3% of Norway’s industrial employment).

Map 4.2: The location of the study areas of Jæren and Horten



In 1994 TESA had 13 member firms with more than 2.800 persons employed and a turnover of 2.2 billion NOK. The TESA-firms have overall a very high export share with an average of 63% (i.e. 1.4 billion NOK in 1992). However, in some of the firms a far larger share is exported; three firms had an export share of more than 90% in 1992 (Lærdal (medical equipment) 96%, ABB Flexible Automation (painting robots) 96%, and Kverneland (farm-machinery) 91% (increasing to 94% in 1993)). According to the firms, without the inter-firm technological co-operation within TESA, the development of this very strong competitive advantage would not have been possible.

As part of the work to promote the member firms competitive advantage, TESA took an active part in the establishment of JÆRTEK (Jæren's technology centre) in 1987. The aim of JÆRTEK is to offer training, preparing workers and pupils in technical schools for the advanced industrial work of tomorrow, and to secure the competence basis for a continued, rapid technological development. To achieve this, the first complete CIM-equipment in Norway was installed in JÆRTEK. Later the CIM concept was diffused to several other member firms, among them Kverneland, which used the investment in CIM to combat the reduced demand for agricultural machinery in Europe through increased productivity and competitiveness. This strategy resulted in a strong increase in the turnover in 1994 and 1995, which made Kverneland the largest producer of ploughs in Europe.

The most well-known firm at Jæren is ABB Flexible Automation, which was called Trallfa Robot before it was bought by ABB in the late 1980s. At that time Trallfa Robot supplied around 50% of the European market for painting robots to the car industry. If ABB had applied their normal restructuring strategy, the robot production at Jæren should have been closed down, and moved to Västerås in Sweden, where the production of handling robots took place at a much larger scale. Instead, the production capacity at Jæren has been increased from 200 robots in the early 1990s to 600 in 1995, and an expected number of 1.000 in 1996. This means that ABB Flexible Automation today covers 70% of the demand for painting robots in the European car industry, and 30% in USA. The work force has been increased by 80 persons from 1994 to 1996, reaching a total of 230 employed, with a turnover of around 290 million NOK in 1995, becoming the most profitable ABB-unit in Norway. In addition, the factory at Jæren has been upgraded to a so-called "supplying unit" in the ABB corporation, and the production of handling robots has been transferred from Västerås to Jæren.

The reasons for the success story of ABB Flexible Automation is partly to do with the informal, tacit knowledge and social qualifications of the work force (i.e. Marshall's "industrial atmosphere"), and partly with the localised, codified knowledge constituted by the specific, disembodied technical knowledge of painting robots at the factory at Jæren, and the general, interactive learning-based knowledge of robot technology in TESA, which represents region specific "untraded interdependencies", recognised by ABB as being extremely important for the competitive advantage of ABB Flexible Automation (Asheim and Isaksen 1995).

The close, horizontal inter-firm cooperation, resulting in the development of core technologies (**radical** process innovations), existing in this district is rather unique in an international context. The technological cooperation was strongly dependent on the high level of internal resources and competence of the firms, and did not involve R&D institutions in the regional "capital" of Stavanger. However, in later years, regional and national R&D institutions have gradually become more involved in the R&D work (e.g. Rogaland Research in Stavanger, Chr. Michelsens Institute in Bergen, and SINTEF at the technical university in Trondheim). In addition, the region is characterised by strong common values (i.e. the Protestant work ethic) and close family ties in the communities (Asheim 1993).

This successful example of inter-firm technological cooperation within TESA can be used to focus on structures enabling interactive learning in a network of firms. These can be summarised as follows (Asheim 1994):

1. The collaboration within TESA is on **process** innovation and **not** on **product** innovation. This factor further strengthens the qualitative dimension of co-operation by stressing technological development of common interest to all participating firms (i.e. new production techniques);
2. The production system is characterised by horizontal specialisation or complementarity in products. Brusco, also, points out that cooperative ventures, especially concerning technical innovations, are credited with creating less difficulties between firms doing different things (Brusco 1986, 1990);
3. The initiative to establish TESA was taken by the local industry, which corresponds to Brusco's recommendation of involving individual entrepreneurs in the development of such centres (Brusco 1989).

We would argue that there exists a territorially embedded, regional innovation system at Jæren, where TESA, as a "Business service centre", is at the core of the system, and where the collaborating partners have been extended from the original local firms and technical schools to comprise regional and national R&D institutions. However, the local industry is still governing activities through TESA, which also functions as a secretariat for all industrial robot research in Norway. This embedded regional innovation system has played a key role in securing the competitiveness of the local industry, and will also have an important role to play in the future in promoting the industrial renewal necessary to upgrade some of the more traditional firms in the farm-machinery branch to higher value-added products. The basis for doing so must be said to be excellent against the background of the high technological competence represented by the TESA-firms.

4.5 The electronics cluster of Horten

Another well-known specialised industrial agglomeration in Norway is the electronics industry in Horten, a medium sized town with 23 000 inhabitants south of Oslo, located just above 90 minutes travelling distance to Oslo, thus belonging to the category of “medium sized towns” (Map 4.2). The electronics industries in the area have several internationally competitive firms with considerable product development: the firms form a local production system, but one which does not constitute a territorially embedded regional innovation system, in contrast to the mechanical engineering industry at Jæren. Rather the product innovative electronics companies in Horten are part of a national - and to some extent an international - innovation system.

The electronics industry in Horten comprises about 1 300 jobs and 25 firms in the middle of the 1990s; a bit more than 5% of all employees in this industry in Norway. However, Horten stands out as the best known “electronics milieu” in Norway. Certainly, the capital region has a larger number of jobs in the electronics industry, but Horten is definitely the area in the country where the electronics industry, relatively speaking, is the most important, as illustrated with a locational quotient of more than 10 within this industry. In addition, the electronics industry in Horten has experienced much faster job growth than the national average since 1970, while the capital region has experienced great employment losses.

There is a considerable local production system within the electronics industry in Horten. Currently the area has three large system houses (with more than 100 employees) and five smaller ones, as well as two OEM (Original Equipment Manufacturing) suppliers. The system houses have their own products which are sold to final customers. The OEM suppliers have their own products as well, but these are components used by system firms (outside Horten and Norway). Most of the production itself, chiefly in the system houses, is carried out by subcontractors, usually local ones. The system houses are responsible for assembly and final testing of the products, as well as the development of new products and the maintenance of older models.

The system houses and the OEM suppliers are very product innovative. Periodically, several firms have used as much as 20% of their turnover on new product development. In the large system firms and the OEM suppliers, the advanced product development takes place in co-operation with the national technological research institutes in Norway, and also with some large customers and electronics firms in other parts of the country, and in some instances abroad. Some of the firms are owned by foreign companies, and co-operate with R&D departments in these companies on innovations. All the firms have their R&D departments in Horten, but one has also established a research laboratory near the University in Oslo, a consequence of the difficulty of recruiting top senior researchers to Horten. The development of new products in the large firms is normally funded by the Norwegian Research Council, emphasising that these firms are part of a national innovation system. Thus, we would argue that there exists a regionalised national innovation system in Horten, where most of the innovation activity is guided and carried out by the R&D departments in the large electronics firms.

However, there also exists a local production system in the electronics cluster in Horten. There are mainly two different kind of subcontractors in this production system. Firstly, those primarily involved in the production of printed circuit boards to system houses or other subcontractors. These firms rarely co-operate on innovation with system houses. The relationship between system houses and subcontractors is characterised by asymmetrical relations of power. The subcontractors must rely on a considerable numeric flexibility, achieved through overtime work, hiring people on short term contracts, the use of “home-workers” (putting out), as well as subcontracting by the subcontractors themselves.

Secondly, some subcontractors have their own products and significant technological competencies in some fields . These are both electronics firms and firms in other industrial sectors, mainly mechanical engineering. These firms often have long-term contacts with system houses, and co-operate with these in developing components for the system houses’ new products, contributing to the formation of a territorially embedded regional innovation system. However, as emphasised, Horten does not constitute such an innovation system; there is an almost total lack of horizontal co-operation between system houses in the areas, hardly any research and educational institutions in Horten appropriate to the needs of the system houses, and most contacts regarding advanced innovation activity in the system houses are with research institutions and firms outside the Horten area.

5. Policy implications

This section of the paper discusses how to design a regional innovation policy for Norway on the basis of the theoretical clarifications and empirical analyses carried out.

5.1 Towards an innovation based regional policy

There are several reasons why it is vital to have an innovation based regional policy. Firstly, innovation and technical change are central to economic growth in regions as well as countries. To stimulate innovation activity should therefore be *one* important element in regional policy. Secondly, a regionalization of innovation policy is necessary, since innovation - as shown in this paper - occurs differently in different regions, depending on the firm and industry structure, as well as on varying social and cultural conditions. "Therefore, there is a need for a decentralised political base allowing for differentiation in policies" (Hassink 1996: 180). Thirdly, innovation is often a territorial phenomenon, as shown most clearly in the Jæren example. This indicates that the innovation process is in part based on formal and tacit knowledge, norms and institutions that are place-specific. A regionally differentiated policy is necessary to make use of such specific territorial recourses. Thus, there is no one regional innovation policy that can be applied to all areas.

The regional innovation policy pursued in Norway until now has largely been to communicate research and development competence to small and medium-sized firms in non-central areas in particular. 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 SMEs 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 idea is that SMEs in that way will have at their disposal the technological competence in the whole national R&D sector, and obtain the opportunity for technological renewal that they cannot carry out on their own. 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 regional innovation policy in Norway corresponds with important elements in the policy in other countries. Generally, a central aim of regional innovation policies has been "to support regional endogenous potential by encouraging the diffusion of new technologies in general and the diffusion of new technologies from higher education institutes ... and public research establishments ... to small and medium-sized enterprises in particular (Hassink 1996: 167).

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 take into account knowledge from modern innovation research. Innovation is multi-faceted and complex, involving more than R&D alone, despite the fact that research and development does have an important role for many firms in solving problems during the innovation process. Firms carry out many other activities such as trial production, design, and market research, and they face many more problems than simply generating R&D results. Modern innovation research also reminds us (as underlined in Section 2) of the interactive nature of the innovation process, that is, the fact that innovation almost always takes place in co-operation with other firms and institutions, thus making the concept of **innovation system** relevant.

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 enterprise, for whom **regional embedded innovation** systems are particularly important (cf. Table 2.2). Chabbal (1995: 109) thus argues that "innovation policy is aimed primarily at SMEs.(...) 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". 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). Most traditional SMEs do need help from intermediary organisations to acquire technological knowledge from research institutes (Hassink 1996). 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.

How then should a Norwegian regional innovation policy with a special view to SMEs be designed? Taking seriously the need to adapt policy to varying local conditions, we will discuss the formulation of regional innovation policy for each of the three main area-types the country has been split into, describing important regional differences in innovative activity:

1. Peripheral areas with little manufacturing, and small chances for hosting an industrial agglomeration except one-company towns.
2. Peripheral areas with manufacturing and industrial agglomerations, most often in traditional manufacturing industries.
3. Central areas with a many-sided industrial base, and industrial agglomeration also in knowledge-intensive and high-technology industries.

5.2 Peripheral areas with little manufacturing

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 consultants.[16]

Thus, there are normally few local firms with which to co-operate, and there are also few service firms and R&D institutions in the area. Hence broker organisations may have an important task in bringing especially traditional SMEs in such areas in contact with R&D-institutions and firms in other parts of the country. The functions of these organisations 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 competencies needed by the firm, and c) advise firms (SMEs in particular) in order to compensate for a lack of knowledge within the firms (Bessant and Rush 1995). Broker organisations are an important part of the innovation support system needed in peripheral areas.

In peripheral areas "it is of utmost importance that one broker organization is proactive (and) receiver-oriented" (Hassink 1996: 180). The organisation should employ senior engineers with extensive business experience who visit local firms frequently in order to help them to define their technological and relating financial, marketing and organisational problems. The public support programme named "The Innovation and New Technology Programme for Northern Norway" (the NT Programme) acts as such a broker organisation. In a recent evaluation, the programme is regarded as a state of the art for this kind of public support structure (Isaksen et. al. 1996)[17]. The NT programme is also presented as a starting point for designing similar approaches in other peripheral parts of Norway.

The main aim of the NT programme is to "promote new activities in Northern Norwegian companies that have the ability and drive to innovate. This will be done by investing capital in company projects with potential"[18]. The programme thus gives financial support to product and process development as well as market development in Northern Norway. 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". However, it is mainly the working methods of the NT programme which make this a very successful programme, and merits the term "a state of the art programme".

The working methods are summarised as follows:

1. The NT programme focuses particularly on innovation. It has the entire region of Northern Norway as its catchment area, and is run by an independent secretariat. Focusing on innovation and Northern Norway means that the secretariat has built

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[16] The typical example of this area-type in Norway is the county of Finnmark. Finnmark is only weakly industrialised, with about three-quarters of manufacturing employment in fish-processing (Wiig 1995).

[17] A large part of Northern Norway may be denoted a peripheral region with little manufacturing. Northern Norway has significantly fewer employees in manufacturing compared to the country as a whole. Northern Norwegian manufacturing also has an extremely low level of research and development.

[18] Quote from "NT-programmet 1993-1996. Strategi og måldokument" (p. 2)

up specialised knowledge needed to carry out development projects, and knowledge about Northern Norwegian business conditions.
2. The programme selects the “best” Northern Norwegian firms, that is, firms that are oriented towards innovation and have the financial and human resources necessary to carry out development projects. Several studies have similarly shown that, within any particular sector or region, only a limited number of firms carry out most innovative activity, whilst the majority of firms innovate extremely rarely. Identification of this “innovative core” is thus important for innovation support programmes.
3. The NT programme provides all-round support to firms; financial support, advice and guidance in many fields, as well as assistance in finding partners for co-operation on projects. Other programmes in Norway tend to concentrate on one stage in the innovation process, such as commercialisation of ideas from research centres, co-operation between firms and R&D institutions or co-operation with clients. The NT programme provides support for innovation **per se**, and not simply for particular stages in innovation processes.
4. Another feature is the active follow-up of firms and projects that the NT programme provides. For instance, the NT programme case handler acts as observer at the project management group. Case handlers also try to bring in outside members - possibly potential clients - to the project board. An important part of following up projects is also to find leading customers.
5. A final feature is the long-term nature of the NT programme’s connection with firms. The programme’s target group of innovation-oriented firms is followed up over long periods of time, often with several projects running at one time in the same firm.

5.3 Less central areas with manufacturing

In the second area-type we find relatively high levels of manufacturing, in general linked to one or a small number of sectors, mainly in traditional manufacturing industries. 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, and firms have a greater share of innovation costs associated with R&D and are directed more towards radical innovation than firms in area type 1.

In area type 2, conditions are more conducive to the creation of regionally embedded innovation systems, particularly in areas with industrial agglomerations and several firms in the same production system. This makes local 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. The formation of regional innovation networks is often spontaneous, although the networks may be strengthened by the planned realisation of regional institutions.

However, other industrial agglomerations of SMEs may lack regionally embedded innovation systems, as concluded in the innovation survey in the county of Møre og Romsdal in the north-western part Norway (Wiig and Wood 1995), a county with significant manufacturing milieus[19]. The county 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" seems to dominate.

It is precisely this lack of co-operation between firms and R&D and educational establishments in the county that stops us from characterising the manufacturing milieu in Møre og Romsdal as a regionally embedded innovation system. 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 local firms, a perception which limits co-operation between firms in the same sector. Small firms in particular fear imitation (Wiig and Wood 1995).

However, there exist potentials for creating regional systems of innovation in Møre og Romsdal, and some kind of technology centres seem relevant to that task[20]. The many small firms in traditional industries in the county have little opportunity to carry out R&D on their own, and have problems in obtaining necessary information about technological development from institutions in the county. The establishment of local technology centres in Møre og Romsdal, would also face the important task of improving innovative 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). While it may be difficult to bring about co-operation between competitive firms, the example of TESA in Jæren shows that this type of co-operation can be successful where it concerns improvement of process innovations, which can benefit all firms.

Furthermore, 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. Small firms in particular 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. Thus, several firms in the county co-operate on innovation with customers abroad (Almestad 1996).

The industrial and firm structure in the county point to a need for technology centres which function as technology transfer agencies to help firms solve specific technical questions (Hassink 1996). The transfer agencies function partly as brokers (like the NT programme) linking up firms with technical colleges and research institutions inside as well as outside the county, but they may also carry out learning, as well as

[19] Møre og Romsdal has several specialised industrial agglomerations of SMEs, more precisely three in both the furniture industry and shipbuilding, and two in textiles and clothing.

[20] Firms in Møre og Romsdal also experience difficulty in obtaining capital to finance innovative activity, and in obtaining highly qualified personnel (Wiig and Wood 1995). Thus, there is also need for traditional regional policy tools such as capital support and support for the recruitment and training of labour.

experimental and development work in co-operation with firms. As Møre og Romsdal has a concentration of firms in specific industrial sectors, these agencies may build up competence in the sectors in question especially.

5.4 Central areas with high-technology industries

The last area-type is made up of central regions where there is a many-sided industrial base, and where most of Norway's high-technology industry is located. The central regions have relatively high levels of innovative activity, which in the most central areas reflects large numbers of firms in innovative industries. Firms in these areas, and in particular in the cities, make most use of R&D in the innovation process, and innovation activity is most often directed towards radical innovations.

These areas have good conditions for the creation of regional innovation systems. However, as firms often co-operate with national, basic research institutions, they are, thus, part of national innovation systems, as is the case with the electronics industry in Horten. Firms may also co-operate with local firms and institutions, but the importance of national institutions means that central areas often hold regionalised national innovation systems.

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, many higher education institutes and most of the high-technology industry, it will be important to stimulate contact between these actors.

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, some of which are specialised within certain sectors. The aim of these technology parks is to locate research institutions, universities and other higher education institutes teaching in scientific technical fields, and innovative firms together, in order to increase synergy effects through daily contact. Technology parks offer certain services, such as consultancy and administrative services, and stimulate collaborative agreements between firms and institutions. Such parks may be established by local or regional authorities, but also by, for example, universities or research institutes (e.g. as is done in the main Norwegian university cites Oslo, Bergen and Trondheim).

Technology parks comprise an agglomeration of highly innovative activities in a restricted geographical area. We see the "agglomeration" model as most relevant, as it tries "to take due advantage of the research and industrial potential already existing, rather than trying to relocate R&D and technology agents in new sites (March Chordà 1996: 147). 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 type 2. These parks are more concerned with the commercialisation of new research results, and are thus based on the linear innovation model, whilst technology centres are mostly concerned with transferring already-existing technology to small and medium-sized firms, which is more like the interactive innovation model.

Collaboration in R&D between firms and research institutions often takes place on a nation-wide and even international scale (March Chordà 1996), as is the case with electronics firms in Horten. It is not appropriate to establish a “full-scale” technology park in a small place like Horten either, as the local area cannot fulfil the innovative firms’ need for advanced R&D competence. Nevertheless, it is important to try to strengthen the local innovative milieu, particularly seeing that many large firms in Horten are externally controlled. A more innovative local industrial milieu might increase the likelihood of companies continuing their investment in Horten firms, instead of turning to firms in other places (cf. Morgan 1995). Making the industrial milieu more innovative may involve adjusting education at the regional college better to the needs of the electronics industry and also to encourage high-quality local suppliers, i.e. to stimulate the formation of a territorially embedded innovation system to supplement the regionalised national system in the area.

6. Conclusion

The distinction between the two different types of regional innovation systems, a regionalised, national system and a territorial embedded system respectively, is both important and valid. This is especially the case against the background of alternative, modern theories of innovation, where innovation is looked upon as essentially a social process, and the empirical experiences of endogenous regional development based on agglomerated, networking SMEs, where industrial growth is understood as a territorial process. This perspective favours the kind of policy approaches which are (Storper and Scott 1995, 513):

a) context-sensitive, i.e. concerned with the embeddedness of industrial practices in specific contexts and regions (as shown in our discussion of regional innovation policy tailored to three different area-types in Norway);
b) production-systems-oriented rather than firm-oriented; and
c) directed towards the ongoing adjustment capacities of regional economies, rather than once-and-for-all implementation of so-called best practices.

The view of interactive learning as a fundamental aspect of the innovation process provides the ground for an interactive innovation model, which is greatly facilitated by geographical proximity and territorial agglomeration. The empirical analyses in the paper also demonstrate that the interactive model most accurately describes how innovative activity takes place in Norwegian manufacturing, as well as indicating that being in an industrial agglomeration really makes a difference for firms.

One way a territorially embedded, regional innovation system can stimulate the diffusion of interactive learning in order to promote radical innovations is by upgrading production systems dominated by vertical relations between principal firms and their subcontracters, which is the normal form of networking in the typical industrial district, to learning systems based on horizontal relations between principal firms and their suppliers (Asheim 1996).[21] This points to the importance of the regional level, as "the **region** is a most appropriate economic and administrative entity around which to plan networking approaches" (Cooke 1994, 33).

However, as pointed out by Storper (1995a), the nation, individual sectors as well as sub-national regions all have an important role to play in implementing a successful technology policy. Thus, for a regionally embedded innovation system to bring about radical innovations there is often a need to supplement the informal, tacit and local codified knowledge in this kind of innovation system with R&D competence and more systematically accomplished basic research and development. In the long run most firms cannot only rely on services from territorially embedded innovation systems. Firms may also have access to competence from national or regionalised national innovation systems. The strength of the traditional, place-specific and often informal competence must be integrated with codified, more generally available and

[21] This implies a transition from "a conventional understanding of production systems as fixed flows of goods and services to dynamic systems based on learning" (Patchell 1993, 797).

R&D-based knowledge, i.e. to link regionally embedded innovation systems closer to national innovation systems.

In addition it is necessary to remember that a strategy of endogenous regional development cannot be applied across the board, as the necessary requirements concerning socio-cultural and socio-economics structures are only to be found in relatively well-off regions, and the sufficient techno-economic and political-institutional structures only in relatively developed nations. The fostering of economic and social development in less developed regions is still a policy task for national governments, "whose power in spatially distributing infrastructure, R&D, education and other preconditions of development, remains essential" (Storper and Scott 1995, 523). Allowances are made for this in Northern Norway where the NT Programme, financed by the Norwegian Industrial and Regional Development Fund and the Ministry of Local Government and Labour, aims to increase innovation activity among firms in that part of the country. Thus, we are in agreement with Storper and Scott when they conclude that "the regionalization of industry policy is necessary to competitiveness in the contemporary world economy, but ... it is neither functionally nor geographically sufficient to ensure all dimensions of competitiveness or the elimination of regional inequalities" (Storper and Scott 1995, 524).

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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.